April 2003

Economic Analysis of Personal Watercraft Regulations in Lake Mead National Recreation Area

Final Report

Prepared for

National Park Service
Environmental Quality Division
Dr. Bruce Peacock

Prepared by

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1 Introduction

Historically, NPS classified PWC with other water vessels, which allowed their use when the use of other vessels was permitted. More recently, NPS has reevaluated its methods of PWC regulation. This report describes the results of an economic analysis of the proposed alternatives for regulating PWC use in Lake Mead National Recreation Area (LAME).

Historically, the National Park Service (NPS) classified personal watercraft (PWC) with all other water vessels, which allowed people to use PWC when the use of other vessels was permitted by a Superintendent's Compendium.[1] In recognition of its duties under the Organic Act and NPS Management Policies, as well as increased awareness and public controversy, NPS reevaluated its methods of PWC regulation. Because of new information regarding potential resource impacts, conflicts with other users, and safety concerns associated with PWC use, NPS proposed a PWC-specific regulation in 1998. The regulation stipulated that PWC would be prohibited in units of the national park system unless NPS determines that PWC use is appropriate for a specific unit based on that unit's enabling legislation, resources and values, other visitor uses, and overall management objectives (63 FR 49,312–17, September 15, 1998). This report describes the results of an economic analysis of the proposed alternatives for regulating PWC use in Lake Mead National Recreation Area (LAME), which is located in southeastern Nevada and northwestern Arizona.

During a 60-day comment period, NPS received nearly 20,000 comments on this proposed regulation. As a result of public comments and further review, NPS promulgated an amended regulation in March 2000. This amended regulation allows NPS to permit PWC use in 11 units by promulgating a special regulation and in an additional 10 units by amending the Superintendent's

[1] A compendium is an NPS management tool used specifically by a park superintendent to take actions to address park-specific resource protection concerns.

Compendiums (36 CFR 3.24[b], 2000). LAME was specifically identified as one of these areas. Water-based recreation was a primary purpose for the establishment of LAME and it is characterized by substantial motorized watercraft use. The March 2000 regulation provided park units a 2-year grace period in which PWC use could continue, after which time PWC would be banned from any park that took no action to promulgate either PWC-specific regulations or to regulate PWC use in the Superintendent's Compendium.

On August 31, 2000, Bluewater Network *et al.* filed a complaint with the United States District Court for the District of Columbia against NPS alleging, among other things, that the NPS rule-making decisions to allow PWC use in some park units after 2002 by making entries in Superintendent's Compendiums would not provide the opportunity for public input. In addition, the environmental group claimed that because PWC cause water and air pollution, generate noise, and pose public safety threats, NPS acted arbitrarily and capriciously when making its September 1998 and March 2000 decisions.

A settlement agreement between NPS and Bluewater Network was signed by the District Court on April 12, 2001. The agreement requires all park units wishing to continue PWC use to promulgate special regulations only after each unit conducts an environmental analysis in accordance with the 1969 National Environmental Policy Act (NEPA). At a minimum, the NEPA analysis must evaluate the impacts of PWC on water quality, air quality, soundscapes, wildlife, wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety. In addition, NPS is required by federal statutes, including Executive Order 12866, to conduct a benefit-cost analysis of the proposed regulation and analyze the impact of the regulation on small businesses under the Regulatory Flexibility Act (RFA) of 1980. Based on this settlement, PWC use in LAME was to be prohibited as of September 15, 2002 if a final rule permitting their use was not promulgated. However, a stipulated modification to this settlement agreement was approved by the court on September 9, 2002 that permitted unrestricted PWC use until November 6, 2002 and restricted PWC use until December 31, 2002. On December 24, 2002, the NPS and the Bluewater Network reached a second settlement agreement to extend restricted PWC use until

April 10, 2003. If a rule allowing PWC use is not promulgated by April 10, 2003, PWC use in LAME would be prohibited until such a rule were published.

This report describes the results of an economic analysis of the proposed alternatives for regulating PWC use in LAME, as required by the terms of the April 2001 settlement and by applicable federal statutes.

1.1 ORGANIZATION OF REPORT

This report presents the NPS' economic analysis of the alternative LAME PWC regulations under consideration. The report is organized as follows. Section 1 describes the reason for the regulation and the current and proposed regulations at LAME. Baseline visitation, environmental conditions, and economic activity in LAME are described in Section 2. The local economic impacts on the region surrounding LAME are summarized in Section 3. Section 4 describes the methodology for assessing the impacts of the alternatives on social welfare and presents a cost-benefit analysis of the regulatory alternatives. Section 5 provides an analysis of the regulatory alternatives' impacts on small businesses. In addition, Appendix A describes the principles of economic impact analysis and Appendix B includes a detailed theoretical discussion of the types of benefits and costs associated with PWC restrictions in national parks and the methods used in their estimation.

1.2 PROBLEM ADDRESSED BY REGULATION

The U.S. Office of Management and Budget (OMB) directs regulatory agencies to demonstrate the need for their rules (OMB, 1992). In general, regulations should be imposed only where a market failure exists that cannot be resolved efficiently by measures other than Federal regulation. If each producer and consumer has complete information on his or her actions and makes decisions based on the full costs of those actions, resources will be allocated in a socially efficient manner. However, when the market's allocation of resources diverges from socially optimal values, a market failure exists. A defining feature of a market failure is the inequality between the social consequences of an action and a

In general, regulations should be imposed only where a market failure exists that cannot be resolved efficiently by measures other than Federal regulation. The justification for restricting PWC use in national parks is based on externalities associated with their use.

purely private perception of benefits and costs. The major causes of market failure identified in the OMB guidance on Executive Order 12866 are externalities, natural monopolies, market power, and inadequate or asymmetric information. For environmental problems resulting from market failures, this divergence between private and social perspectives is normally referred to as an externality. Such divergences occur when the actions of one economic entity impose costs on parties that are external to, or not accounted for in, a market transaction or activity.

The justification for restricting PWC use in national parks is based on externalities associated with their use. For instance, the operation of PWC imposes costs on society associated with noise emissions, air and water pollution emissions, and health and safety risks. Because PWC users have little incentive to consider these external costs, they are likely to make decisions about PWC use without taking these impacts on other people into account.

If these externalities are internalized to the PWC users generating them, the problem can be mitigated. For example, if PWC users were required to pay for the marginal external costs they impose on others, they would begin to take those costs into account when making decisions and the market failure would be corrected. However, accurately assigning costs associated with each individual PWC user's actions and enforcing payment is essentially not feasible at this time. Other regulatory options to address the externalities associated with PWC use are far easier to implement and enforce. Some of these options include restricting areas where they are permitted, the time of day when they can be used, and PWC engine type.

The extent to which social welfare improves due to PWC regulation depends on the relative costs and benefits associated with such restrictions. While non-PWC users gain from PWC restrictions, the PWC users and local businesses that serve them experience welfare losses. Thus, the likelihood that a particular regulatory option will improve social welfare in an individual national park unit is dependent on numerous park-specific factors that influence the level of costs and benefits. While a given set of restrictions on PWC use in one park may improve social welfare, the same set of restrictions in another park could easily have negative impacts on social welfare. For example, banning PWC in a park where there is

little other motorized boating activity may result in large proportionate reductions in noise and emissions whereas banning PWC in a park with a high level of other motorized boating activity may not have a noticeable effect on noise or emissions levels. In the latter case, the costs to PWC users could be larger than the gains to other park visitors. Thus, it is important to consider the conditions specific to each individual park in selecting the preferred regulatory alternative for that park.

1.3 CURRENT PWC ACTIVITIES AT LAME

PWC use is currently authorized in all areas of LAME, except where specifically prohibited for safety reasons and where concentrated shoreline-based activities occur, including areas designated for swimming, fishing, and scuba diving. The conditions of the September 6, 2002 settlement agreement remain in effect, and include the following restrictions on PWC use on Lakes Mead and Mohave:

- PWC prohibited in the area from Iceberg Canyon to Pearce Bay,
- PWC prohibited in the area known as the Gypsum Beds and Bonelli Bay,
- PWC prohibited from the confluence of the Virgin River and up the Virgin River to the park boundary,
- PWC prohibited between the Hoover Dam and Eldorado Canyon on Lake Mohave, and
- PWC prohibited in the 200-foot shoreline flat wake zone in the Virgin Basin of Lake Mead and on Lake Mohave from Eldorado to Cottonwood Cove.

State of Nevada, State of Arizona, and NPS boating regulations are in effect for PWC within LAME (see Appendix D of the Lake Management Plan [LMP] Environmental Impact Statement [EIS] [NPS, 2002a] for a comparison).

Although PWC use is currently permitted in LAME, PWC will become banned in the park if no action is taken to continue their use. Thus, a ban on PWC use in LAME is considered the baseline for the analyses in this report.

1.4 PROPOSED ALTERNATIVES

The alternatives proposed by NPS for LAME were developed as part of the LAME LMP EIS (NPS, 2002a). The purpose of the plan is to provide a wide range of recreational opportunities on Lakes Mead and Mohave, improve facilities and services, reduce visitor conflict, address the sanitation and litter issues, and preserve and protect the natural and cultural resources of the recreation area (NPS, 2002a). Only those components of the plan that may restrict or otherwise affect the use, access, or impacts of PWC are considered in this report.

One of the overarching components of the plan is the establishment of recreational settings in specific areas, such as primitive, semiprimitive, rural natural, urban natural, and urban park (see Table 1, [NPS, 2002a] for a complete description). Under the plan, motorized vessels with horsepower (hp) exceeding 65 would not be permitted in semiprimitive areas, and only boats using electric trolling motors would be permitted in primitive areas. Accordingly, PWC use would not be permitted in any area zoned semiprimitive or primitive. The rural natural, urban natural, and urban park settings permit PWC use. However, boating (including PWC) and other water activities may be restricted to varying degrees under these settings based primarily on safety considerations. The proposed alternatives, with the exception of Alternative B, call for an expansion in lake access facilities (marinas and launch ramps) over existing levels. The designation of wakeless areas is also addressed for each alternative. However, these components of the plan are not specific to PWC use and therefore are not discussed in detail. For a complete description of the proposed alternatives and the laws, regulations, policies, impact indicators, criteria, and methodologies used in the impairment analysis and the general management plan, refer to the LMP EIS (NPS, 2002a). A description of the components of the proposed management alternatives relevant to PWC is provided below.

1.4.1 Alternative A (No Action)

The no-action alternative is based on the implementation of the General Management Plan, approved in 1986.

Under the no-action alternative, no unit-specific rule would be developed for the continued use of PWC. Therefore, in accordance with the settlement agreement of April 12, 2001, and the modified settlement agreement approved by the court on September 9, 2002 (and extended on December 24, 2002), PWC use in LAME would be prohibited on April 10, 2003. In addition, NPS is required to evaluate the operation of all fueling facilities on Lakes Mead and Mohave as part of the modified settlement.

1.4.2 Alternative B

Under Alternative B, a unit-specific rule would be developed for the continued use of PWC within the recreation area. All U.S. Environmental Protection Agency (EPA) noncompliant two-stroke engines (including PWC) would be prohibited from LAME within a year of the record of decision for the LAME EIS. In addition, all PWC would be prohibited in the primitive and semiprimitive zones designated in Alternative B, which comprise approximately 10 percent of the water portion of the recreational area.[2] Under Alternative B, PWC would be prohibited in the following semiprimitive and primitive areas on Lake Mead:

- the inflow areas of the Muddy and Virgin Rivers on the Overton Arm,
- the Colorado River Delta from Iceberg Canyon to the boundary of Grand Canyon National Park, and
- the Gypsum Bed areas near Temple Bar.

The West Gypsum Bay area is presently closed to all watercraft for use as a research area.

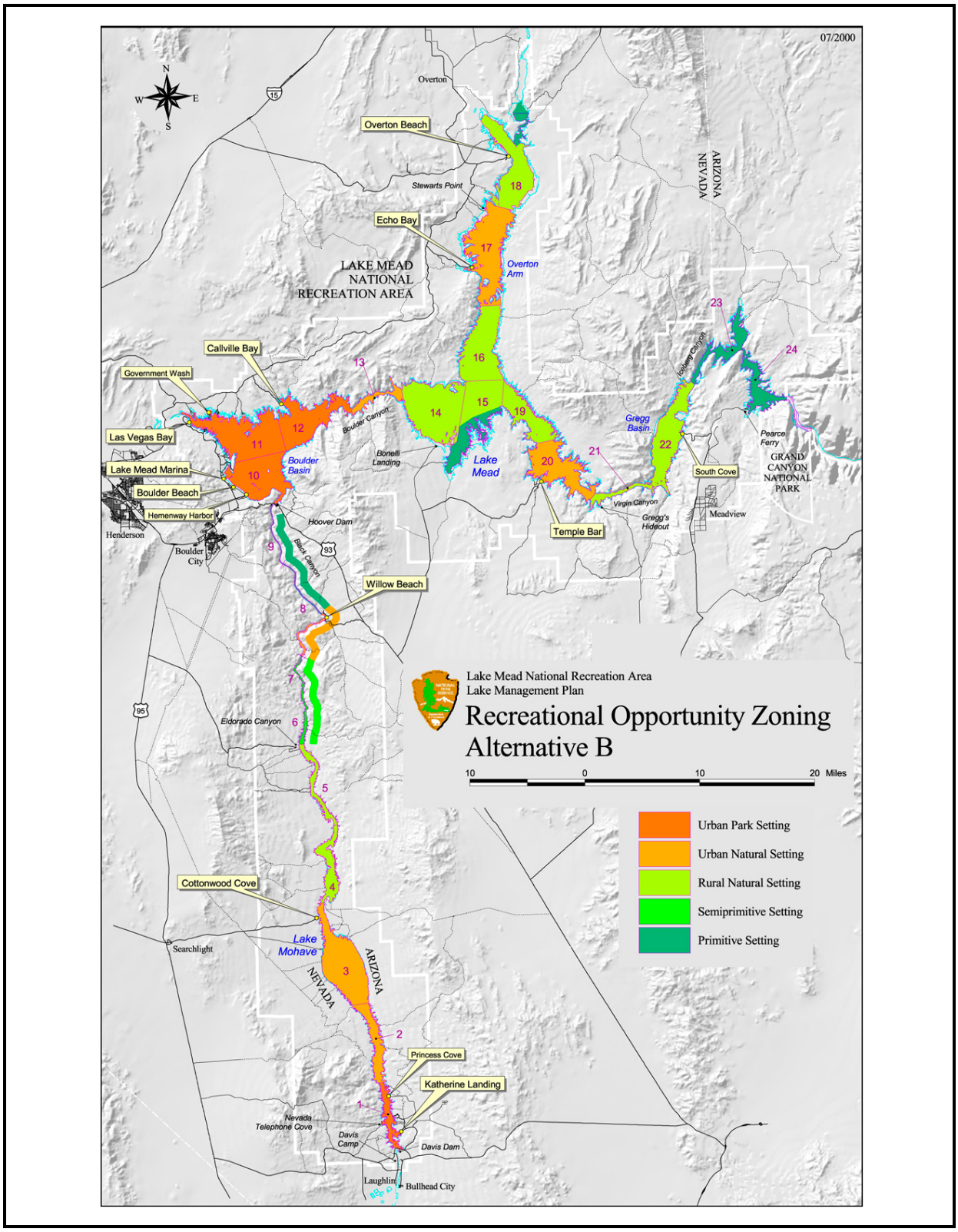
PWC would be prohibited in the following semiprimitive and primitive areas on Lake Mojave:

- the area north of El Dorado Landing to Hoover Dam.

EPA-compliant PWC would be authorized to use the remaining 90 percent of the waters zoned rural natural, urban natural, and urban park as identified in Figure 1-1, except where specifically prohibited by markers or buoys (such as for safety considerations as mentioned in Section 1.3 above). As well, a 100-foot flat wake area is

[2]The area of primitive and semiprimitive zones is based on park management decisions, not existing conditions.

Figure 1-1. LAME Recreational Zoning Under Alternative B



proposed around the entire shoreline of Lakes Mead and Mohave as part of Alternative B.

1.4.3 Alternative C—The Modified Preferred Alternative

Under this alternative, a unit-specific rule would be developed for the continued use of PWC within LAME. PWC would be prohibited in the primitive and semiprimitive zones designated in Alternative C, which comprise approximately 5 percent of the total surface water of the recreational area.[3] Beginning in 2012, EPA standards would be adopted permitting the use of only EPA-compliant PWC in LAME.

On Lake Mead, PWC use would be prohibited in the following primitive and semiprimitive areas:

- the inflow areas of the Muddy and Virgin Rivers on the Overton Arm,
- in the Virgin Basin along the southern shoreline at the Gypsum Beds, and
- Bonelli Bay.

On Lake Mohave, PWC use would be prohibited in the following primitive and semiprimitive area:

- Black Canyon.

PWC would be authorized on the remaining 95 percent of the waters zoned rural natural, urban natural, and urban park (see Figures 1-2, 1-3, and 1-4), except in areas specifically zoned to prohibit all motorized vessels as described below, and other regulated areas marked by buoys or signs for safety reasons. In addition, Alternative C includes a proposed 200-foot flat wake area around beaches frequented by bathers, boats at the shoreline, and near people in the water and at the water's edge.

[3]The area of primitive and semiprimitive zones is based on park management decisions, not existing conditions.

Figure 1-2. LAME Recreational Zoning Under Alternative C

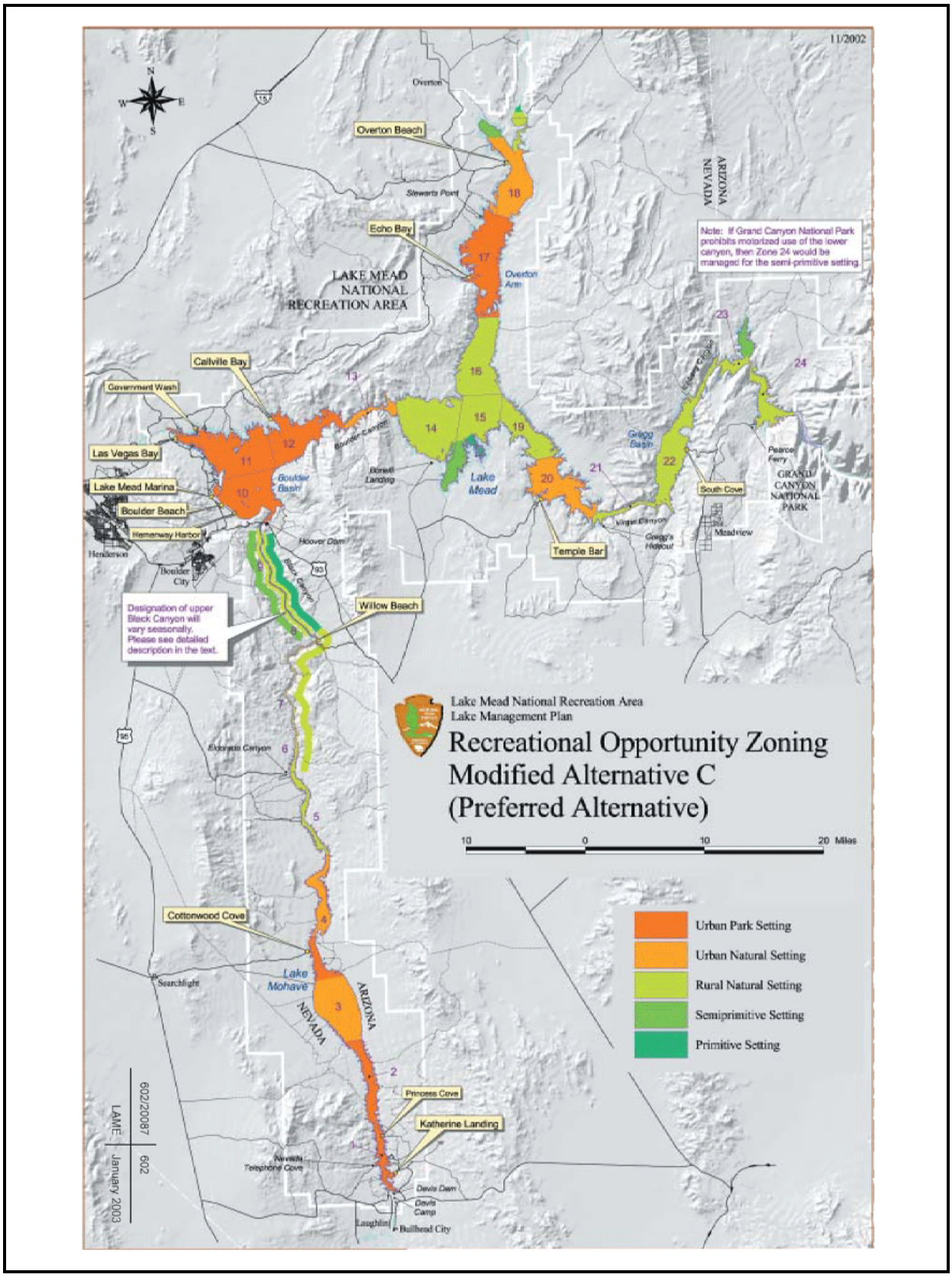
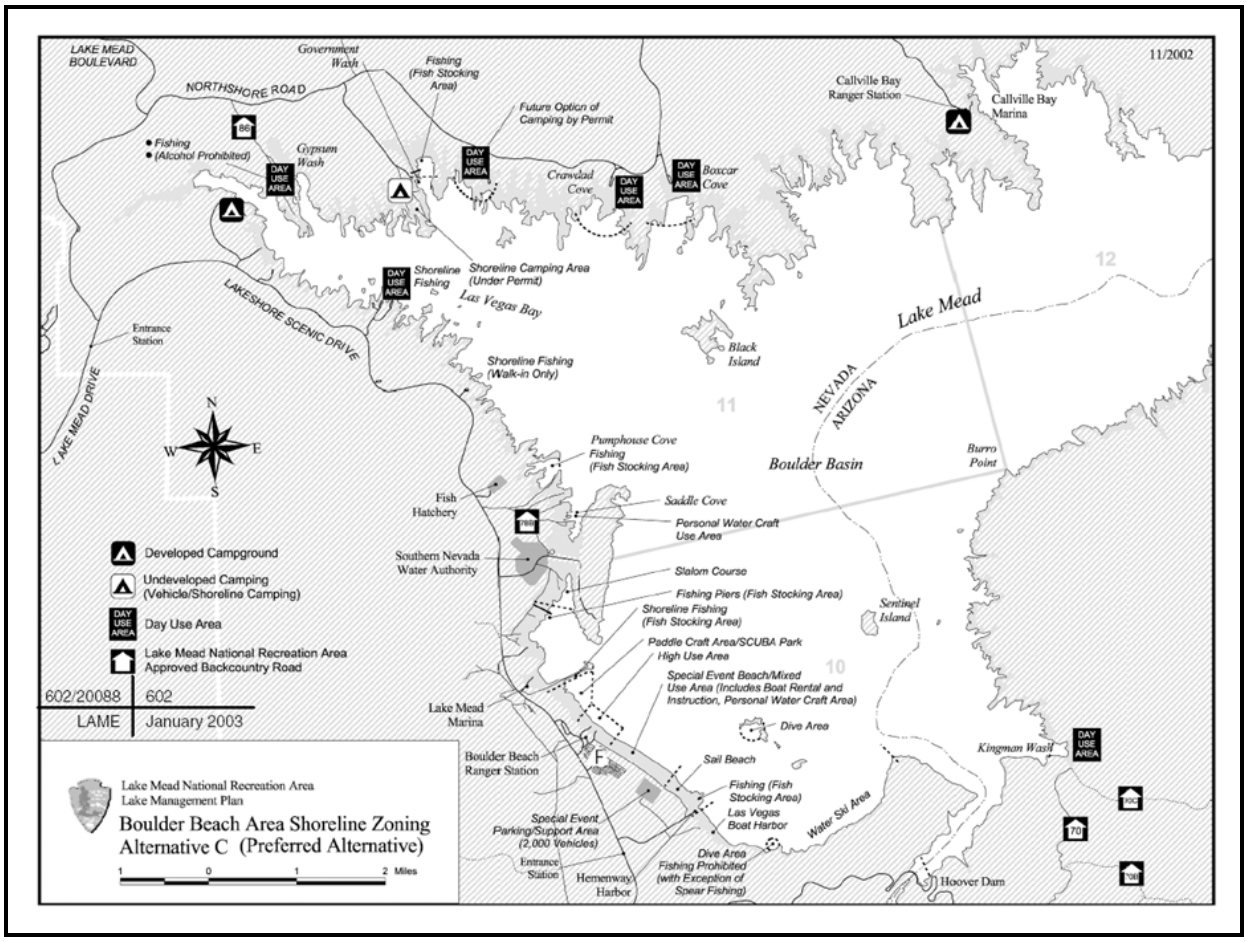


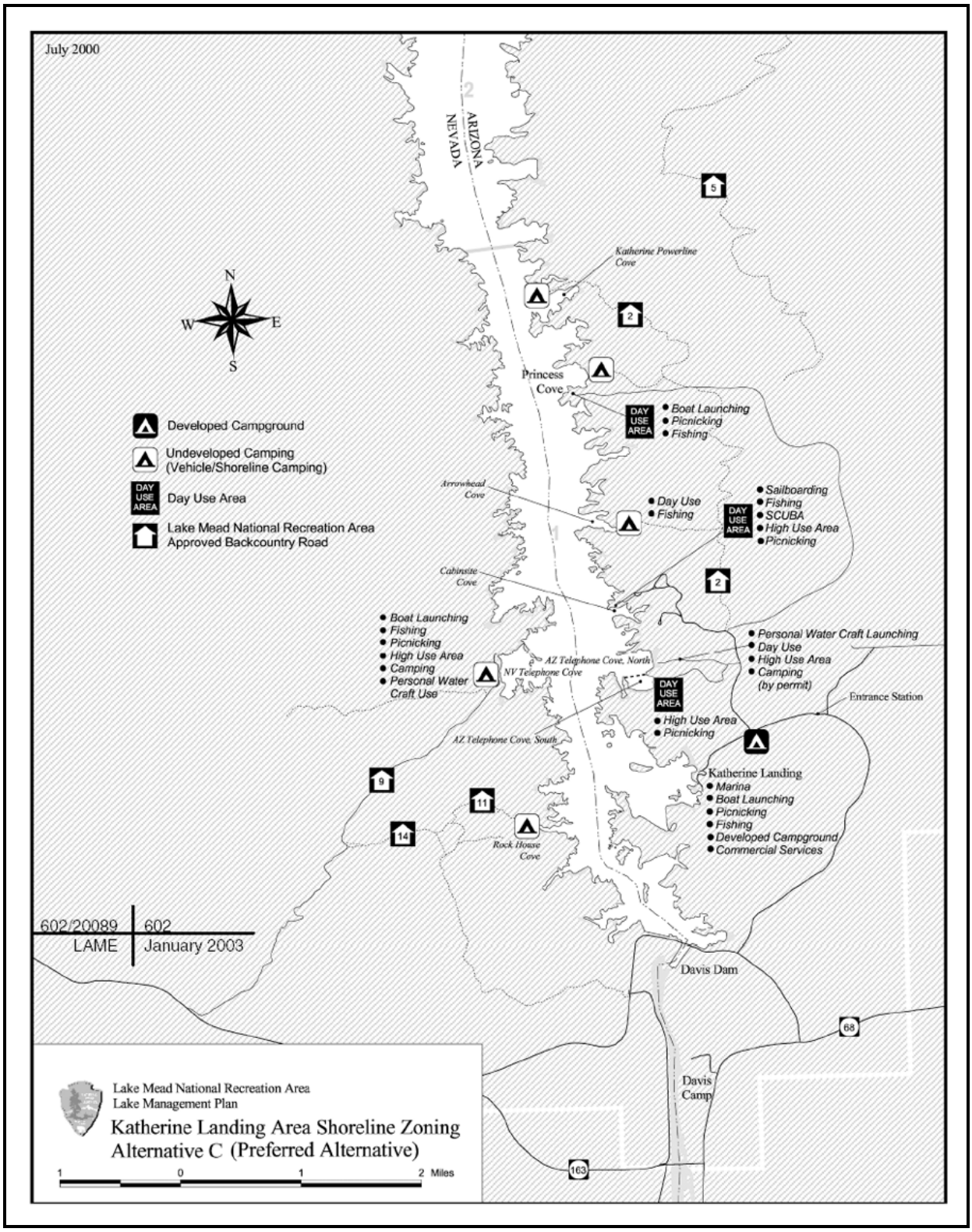
Figure 1-3. LAME Recreational Zoning in the Boulder Beach Area Under Alternative C



1.4.4 Alternative D

Under Alternative D, no areas of LAME would be managed specifically for primitive or semiprimitive opportunities. A unit-specific rule would be developed for the continued use of PWC within the recreation area. This alternative would allow the continued use PWC in all zones of Lakes Mead and Mohave, except where they are specifically prohibited with buoys or signs for safety reasons, as identified in Section 1.3.

Figure 1-4. LAME Recreational Zoning in the Katherine Landing Area Under Alternative C



2 Description of PWC Use in Lake Mead National Recreation Area

LAME, located in southern Nevada and northwestern Arizona (see Figure 2-1), was established after the completion of Hoover Dam in 1936. Under an interagency agreement, the Bureau of Reclamation (BOR) retained control of the dam and the facilities relating to control of water flow and power development, and NPS became responsible for the administration and development of recreation facilities. In 1947, the recreation area was expanded to include Lake Mohave, which was created after the completion of Davis Dam in 1953 (NPS, 2002a).

LAME was officially established as a unit of the national park system on October 8, 1964, "for the general purposes of public recreation, benefit, use and in a manner that will preserve, develop, and enhance, so far as practicable, the recreation potential, and in a manner that will preserve the scenic, historic, scientific, and other important features of the area" (PL 88-639). General recreation use was defined within Section 4(b) of this legislation and included bathing, boating, camping, and picnicking.

The recreation area boundary was modified in 1975 when the Grand Canyon Expansion Bill authorized the transfer of more than 300,000 acres administered by LAME to Grand Canyon National Park (GRCA). The Grand Canyon-Parashant National Monument was established in 2000 and includes approximately 200,000 acres

Figure 2-1. Map of the Area Surrounding LAME

of LAME. This national monument is jointly managed by the Bureau of Land Management (BLM) and NPS and includes 209,297 acres administered by NPS at LAME, of which 156,473 acres are located on the Shivwits Plateau. The designation of the national monument also includes portions of the northern shoreline of Lake Mead, from the Arizona border at Driftwood Cove, east to the boundary of GRCA.

Today the recreation area encompasses approximately 1.5 million acres, of which approximately 13 percent is the lake environment. The major rivers supplying water to the Lake Mead and Lake Mohave reservoirs are the Colorado, Virgin, and Muddy Rivers. The Las Vegas Wash, the outflow for the treated municipal and industrial wastewater from Las Vegas, flows year-round into Lake Mead. At 155,000 acre-feet it is the second highest inflow into Lake Mead annually.

At full pool, Lake Mead has a surface area of 157,900 acres with over 700 miles of shoreline, and Lake Mohave has a surface area of 28,260 acres and 150 miles of shoreline. As indicated above, portions of the recreation area are jointly administered by NPS for recreation and resource protection and by the BOR for project purposes, including a 300-foot zone around the shorelines of both lakes. The BOR manages the lake levels of both lakes. On Lake Mohave, there is an annual 15-foot water fluctuation zone between lake elevations of 630 and 645 feet. On Lake Mead, the water fluctuation can be much more dramatic; in the past 10 years water levels have fluctuated between 1,175 and 1,216 feet in elevation. Lake Mead has four large subbasins (Boulder, Virgin, Temple, and Gregg's Basin) and four narrow canyons (Black, Boulder, Virgin, and Iceberg) located between these basins. The shoreline area includes several large bays, including Grand Wash, Las Vegas, and Bonelli.

2.1 PWC AREA ACCESS, MAINTENANCE, AND ENFORCEMENT

As described in Section 1.3, PWC use is currently permitted in LAME. Motor vessel access to Lake Mead is provided by six marinas and nine paved launch ramps, while Lake Mohave is supported by three marinas and four paved launch ramps (NPS, 2002a). Marinas with launch facilities at Lake Mead are located in

Overton Beach, Echo Bay, Callville Bay, Las Vegas Bay, Lake Mead Resort, and Temple Bar. Launch ramps with no marinas or associated services are located at Government Wash, Kingman Wash, Hemenway Wash, and South Cove. Lake Mojave has public launch facilities at Cottonwood Cove, Willow Beach, Princess Cove, and Katherine Landing. According to NPS staff, approximately 90 percent of PWC users access the lake via paved launch ramps, while the remaining 10 percent access the lake from sand and gravel beaches along the shoreline. Most of the lakeshores comprise rocky slopes or steep cliffs that boats cannot easily access; therefore, only 12 percent of Lake Mohave's total shoreline and 7 percent of Lake Mead's total shoreline are accessible for recreational purposes (NPS, 2002a).

The highest densities of PWC use on Lakes Mead and Mohave appear to be in the Boulder Basin of Lake Mead and in the lower portion of Lake Mohave. PWC congregate in water accessible shoreline areas and are usually operated within 0.5 mile of the shoreline. A typical party includes two PWC and six to eight individuals. A base camp is established along the shoreline and use is rotated among the group. On Lake Mead, use is concentrated at Horsepower Cove, Saddle Cove, and Government Wash. Each of these sites is accessible by vehicle and is within 30 minutes of the Las Vegas Valley. On Lake Mohave, use is concentrated at Arizona and Nevada Telephone Coves and Cabinsite Point. Because of the narrow configuration of the lower portion of Lake Mohave, PWC are required to mix with other boating activities, resulting in boating conflicts.

PWC are also often used as tag-alongs with other boats (e.g., towed behind a houseboat as part of a houseboat vacation). PWC rarely travel to more remote areas of the lake without a support boat. Although towable trailers allow PWC to bring camping gear and fuel to support their visit, these trailers are rarely observed on either Lakes Mead or Mohave.

LAME does not provide any facilities specifically for PWC users. Boat launches are shared with other watercraft, and land-based facilities (e.g., restrooms, picnic areas) are used by all park visitors. Therefore, park maintenance associated with PWC use is incidental to other park operational costs.

LAME does not have law enforcement officials dedicated solely to regulating PWC use, but estimates that about 15 percent of enforcement resources are dedicated to PWC-related issues (Holland, 2003). Other regulatory agencies, such as the Nevada Division of Wildlife, the Arizona Department of Fish and Game, and county agencies, are more involved than NPS staff in enforcing general boating regulations, including PWC. NPS staff were not able to provide statistics relative to incidents and citations associated with PWC use at LAME but indicated that increases in boating collisions are attributable to PWC use. In 1999, PWC accounted for approximately 35 percent of the boating fleet in LAME and were involved in 33 percent of the boating accidents.

2.2 VISITATION DATA

In Sections 3 and 4, NPS presents analyses of the economic impacts and the social benefits and costs of PWC use under alternative regulations in LAME from 2002 through 2012. To support the development of these estimates, Section 2.2 presents projections of baseline PWC and non-PWC visitation for this period and a discussion of the methodology used to calculate the projections. The projected baseline represents visitation to LAME if no action is taken to authorize continued use of PWC (i.e., PWC are banned in the baseline).

2.2.1 Historical LAME Visitation Data

According to NPS reports, the total number of recreational visitors to the LAME area in 2001 was 8,465,547. Table 2-1 provides monthly recreational and nonrecreational visitation for 2001.[1] LAME is adjacent to the Las Vegas Valley, which supports a population of over 1 million residents and is among the fastest growing regions of the nation. LAME is also within a half-day drive of large metropolitan areas of Southern California and Arizona and within a 1-day drive of population centers in Utah. The primary origins of visitors to LAME are Nevada and California (41 percent

[1] A recreational visit is defined as the "entry of a person onto lands or waters administrated by the NPS for recreational purposes" (NPS, 1999). Recreational visits do not include "nonrecreational" visits (defined as "through traffic, trades people with business in the park, and government personnel (other than NPS employees) with businesses in the park") (NPS, 1999).

Table 2-1. Monthly Recreational Visitation to LAME, 2001

Month	Recreational Visits
January	510,732
February	529,922
March	602,594
April	840,001
May	778,010
June	905,404
July	1,003,259
August	1,041,354
September	800,605
October	541,943
November	573,310
December	338,413
Total	8,465,547

Source: National Park Service (NPS). "Visitation Records." <http://www.nps.gov>. As obtained in March 2002b.

each), Arizona (7 percent), and Utah (3 percent) (Graefe and Holland, 1997). The majority of visitors to LAME participate in water-related recreational activities. Annual visitation to LAME in the last 5 years has been between 8 and 10 million visitors per year. Table 2-2 presents annual recreational visitation statistics for LAME.

Table 2-2. Annual Recreational Visitation to LAME, 1979–2001

Year	Recreational Visitation	Year	Recreational Visitation
1979	6,155,100	1991	8,445,016
1980	4,965,601	1992	9,016,525
1981	5,219,266	1993	8,941,225
1982	5,390,496	1994	9,566,725
1983	5,913,768	1995	9,838,702
1984	6,276,562	1996	9,350,847
1985	6,952,147	1997	8,528,420
1986	7,753,333	1998	8,788,055
1987	8,098,685	1999	9,023,943
1988	8,327,850	2000	8,755,005
1989	8,495,295	2001	8,465,547
1990	8,582,223		

Source: National Park Service (NPS). "Visitation Records." <http://www.nps.gov>. As obtained in March 2002b.

2.2.2 Historical LAME Watercraft Visitation Data

PWC, primarily stand-up models, were first observed on Lakes Mead and Mohave in the mid-1970s. From the mid-1980s through the mid-1990s PWC use grew rapidly but then leveled off. There were 11,000 registered PWC owners in Clark County (where LAME is located) in 2000 and thousands more in the region surrounding LAME (NPS, 2002a). According to recent lake use surveys, PWC comprise approximately 35 percent of the boats on the water at any one time during the summer months (NPS, 2002a). In the winter months, PWC use drops to 10 percent of boats at any one time (Holland, 2002). This use has been fairly consistent from 1994 through the present. During a 16-month sampling period (1993–1994) for one lake use study, peak boating use (i.e., Memorial Day weekend in 1993) was 5,381 boats at any one time (BAOT) with 3,269 boats on Lake Mead and 2,112 on Lake Mojave (Graefe and Holland, 1997).

Under high-use conditions (i.e., nonholiday summer weekends), the number of BAOT ranged from 1,146 to 1,632 for Lake Mead and 820 to 1,254 for Lake Mojave. Moderate use levels (i.e., summer weekdays) ranged from 515 to 916 for Lake Mead and 535 to 893 for Lake Mojave. Low use (i.e., winter months) ranged from 257 to 340 for Lake Mead and 79 to 191 for Lake Mohave (Graefe and Holland, 1997).

According to the surveys, during peak use, which is defined as holiday weekends during the summer months, there can be approximately 870 to 1,140 PWC on Lake Mead and 570 to 730 PWC on Lake Mohave. During a typical summer weekend, the use ranges from 460 to 570 PWC on Lake Mead and 370 to 440 PWC on Lake Mohave. The prevalence of PWC varies widely across zones for both lakes, with the greatest concentrations in the most developed zones (NPS, 2002a).

It is estimated that between 80,000 and 145,000 PWC were used in LAME in 2001 (Holland, 2002). Based on data from Graefe and Holland (1997), there is an average of 6.6 people per boating party and an average of 2.2 PWC per boating party with PWC. This corresponds to an average of approximately 3.0 visitors per PWC. Using this estimate of visitors per PWC implies that between 240,000 and 435,000 PWC users visited LAME in 2001,

approximately 3 percent to 5 percent of the total recreational visitors.[2]

According to a report prepared for the Nevada Division of Wildlife, 24 percent of boating trips in the Lake Mead sample were PWC with standard two-stroke engines, while the newer, more fuel-efficient PWC models (with fuel-injected two-stroke or four-stroke engines) comprised approximately 3.6 percent of boating trips. For the Lake Mohave sample, about 46 percent of boating trips used PWC with standard two-stroke engines and 9 percent used fuel-injected two-stroke or four-stroke engine PWC (Hagler Bailly, 1999). Overall, about 14 percent of all PWC included in the study sample relied on the newer, more fuel-efficient engines. This suggests an industry trend towards adopting more fuel-efficient PWC engines. This trend would reduce the incremental costs of the required phase-in of cleaner technology as PWC users replace their older machines with newer, more fuel-efficient ones.

2.2.3 Projected Visitation

Methodology for Projecting Visitation

To project PWC and non-PWC visitation for the years 2002 through 2012, NPS used the following methodology:

1. Calculate average recreational visitation over the five most recent years with data available (1997–2001).
2. Divide the recreational visitation estimated in Step 1 between PWC and non-PWC visitation using estimates of PWC use in 2001 relative to total recreational visits.
3. Project baseline non-PWC visitation for the period 2002–2012 by allowing non-PWC visitation to change from the 1997–2001 average at the population growth rate for the areas from which most visitors to the park originate.
4. Project PWC visitation for 2002 by allowing PWC visitation to change from the estimated 1997–2001 average at the rate that national PWC ownership is changing in the most recent years for which data are available (1998–2001). As shown in Table 2-3, between 1998 and 2001, PWC ownership fell by 1.45 percent annually. This covers the period since national PWC ownership began to decline, which appears to be most representative of what is likely to happen in the

[2] For the purposes of this analysis, it was assumed that 2001 visitation by PWC users was at the midpoint of this range, or 337,500 people (approximately 4 percent of recreational visitation).

Table 2-3. National PWC Ownership, 1991–2001 (Number of PWC)

Year	Ownership
1991	305,915
1992	372,283
1993	454,545
1994	600,000
1995	760,000
1996	900,000
1997	1,000,000
1998	1,100,000
1999	1,096,000
2000	1,078,400
2001	1,053,000

Source: NMMA, 2002a.

near future. However, there is considerable uncertainty surrounding this projection.

5. Assume there would be no PWC use in 2003-2012 under baseline conditions due to the ban scheduled to go into effect April 10, 2003.
6. Project visitation by former PWC users by assuming a certain fraction will continue to visit LAME to engage in activities other than PWC use following the ban. In the absence of survey data, these percentages will typically be based on professional judgment.

Projecting Visitation for 2002 through 2012

Following the methodology outlined above, NPS calculated LAME average annual recreational visitation for 1997 through 2001 to be 8,712,194. According to NPS estimates, approximately 4 percent of 2001 visitors used a PWC in LAME.[3] Assuming that the percentage of PWC visitors remains relatively constant over time, this implies an annual average of 347,333 PWC users and 8,364,861 non-PWC users from 1997 to 2001. NPS projects that non-PWC visitation will grow at the rate of population growth for the counties adjacent to the

[3]Graefe and Holland (1997) estimate an average group size of three people per PWC. NPS staff estimated that between 80,000 and 145,000 PWC were used in LAME in 2002 (Holland, 2002). Multiplying the midpoint of this range (112,500) by 3 gives an estimated 337,500 PWC users in LAME during 2001, or 3.987 percent of total recreational visitors.

park.[4] Using Census Bureau data (2002) to construct weighted averages for population growth in the local counties yields an average annual growth rate of 6.26 percent. This is well above the national average of 0.9 percent and may tend to overstate future growth in park visitation given that visitation has been growing much more slowly than population in recent years and population growth rates for this region are likely to decline relative to their extremely high levels in recent years. However, NPS chose to use this methodology for consistency with analyses of PWC regulations in other national parks and to ensure an objective basis for visitation projections. Because growth in visitation by non-PWC users is proxied by the population growth rate, this assumption may overstate the number of future non-PWC users.[5] As a result, the estimated benefits of restricting PWC use in LAME presented in this report should be considered as based on an upper bound on the number of people that would directly benefit from these restrictions.[6] Table 2-5 presents the projected visitation by current non-PWC users based on applying the annual population growth rate of 6.26 percent to the estimated annual visitation by non-PWC visitors from 1997 to 2001.

Between 1998 and 2001, PWC ownership nationwide fell by 1.45 percent annually.

To project baseline PWC use for 2002, NPS used data on national PWC ownership trends (NMMA, 2002a). Nationally, PWC ownership has declined slightly in recent years, with far larger decreases in PWC sales (see Tables 2-3 and 2-4). Between 1998 and 2001, PWC ownership fell by 1.45 percent annually. According to these data, PWC ownership, and presumably PWC use, has been declining even taking into account sales of new PWC. One interpretation of these data is that there are fewer new users than people choosing not to replace their old PWC when it is no longer useable. As shown in Table 2-4, sales of new PWC have been declining dramatically since 1995 (NMMA, 2002b). We applied the rate of decline in PWC ownership to the estimated average annual PWC use from 1997 to 2001, and the resulting

[4]Clark County, Nevada, and Mohave County, Arizona.

[5]The annual percentage change in the number of PWC users is assumed to be equal to the national average annual percentage change in PWC ownership between 1998 and 2001. Thus, it does not depend on the population growth estimate.

[6]As a sensitivity analysis, the estimated costs and benefits of PWC restrictions in LAME were also calculated assuming an annual visitation growth rate equal to 1 percent. Although this change in visitation growth lowers the estimated benefits of PWC restrictions, it does not alter the qualitative results regarding the sign of the net benefits of regulation.

Table 2-4. National PWC Sales, 1991–2001 (Number of PWC)

Year	PWC Sales
1991	68,000
1992	79,000
1993	107,000
1994	142,000
1995	200,000
1996	191,000
1997	176,000
1998	130,000
1999	106,000
2000	92,000
2001	83,000

Source: NMMA, 2002b.

projections for PWC visitation in 2002 is presented in Table 2-5. As mentioned above, there is assumed to be no baseline PWC use in 2003-2012 because PWC are banned in the baseline.

Finally, many of the former PWC users who can no longer use a PWC in LAME may continue to visit LAME to pursue other types of recreation. It was assumed that 50 percent of those that are projected to stop using PWC in LAME in the baseline due to the ban will continue to visit the park.[7] This percentage is based on professional judgment and reflects the uniqueness of LAME in comparison with nearby recreation areas. Based on the estimated regional population growth rate, the projected change in PWC ownership, and the assumed percentage of former PWC users who voluntarily stop using PWC in the park that will continue to visit the park for other activities, we present the projected baseline visitation for LAME from 2002 to 2012 in Table 2-5. To estimate the incremental impacts of the alternative regulations, the change in visitation relative to these baseline visitation estimates must be

[7] It was assumed that a constant number of former PWC users would be willing to continue visiting the park for other activities in all future years, i.e., the same people who are willing to switch recreational activities within the park in the first year after a ban on PWC use would continue to visit the park in future years.

Table 2-5. Projected Baseline Visitation to LAME, 2002–2012[a]

Year	PWC Users	Non-PWC Users			Total Visitation
		Current Non-PWC Users	Former PWC Users[b]	Total Non-PWC Users	
2002	342,297	8,888,833	4,029	8,892,862	9,235,159
2003	0	9,445,627	175,177	9,620,804	9,620,804
2004	0	10,037,297	175,177	10,212,475	10,212,475
2005	0	10,666,030	175,177	10,841,208	10,841,208
2006	0	11,334,147	175,177	11,509,325	11,509,325
2007	0	12,044,114	175,177	12,219,292	12,219,292
2008	0	12,798,554	175,177	12,973,731	12,973,731
2009	0	13,600,251	175,177	13,775,428	13,775,428
2010	0	14,452,166	175,177	14,627,344	14,627,344
2011	0	15,357,445	175,177	15,532,623	15,532,623
2012	0	16,319,430	175,177	16,494,608	16,494,608

[a]These projections are based on the average annual population growth rate in Clark County, NV, and Mohave County, AZ, the areas adjacent to the park, and one of the fastest growing regions in the U.S. in recent years. The visitation estimates should be considered very optimistic because LAME visitation has not been increasing as fast as regional population in recent years and it may be hard to sustain such rapid population growth in the future. Nonetheless, NPS used regional population growth to proxy visitation growth as an objective estimate that is consistent with the methodology used in analyses of PWC regulations in other national parks.

[b]This category represents visitors who have been using PWC in LAME in the past, but would be willing to continue visiting the park to engage in alternative activities following the ban. In 2002, this value is calculated by assuming that 80 percent of the PWC users that would have voluntarily reduced their use of PWC in the park between 2001 and 2002 (based on recent national trends in PWC use presented in Table 2-3) would continue to visit for other activities. For 2003-2012, the number of former PWC users continuing to visit LAME was assumed to be constant and is equal to the number of former PWC users in 2002 plus 50 percent of the number of people projected to have used PWC in LAME in 2003 in the absence of a ban.

projected. Estimates of the incremental impacts are discussed in Sections 3 through 5.

Section 2.2.4 discusses the uncertainties surrounding these projections. In particular, a recent regulation enacted by the EPA in 1996 may have an impact on baseline PWC use nationally. The rule and its implications are discussed below.

2.2.4 Sources of Uncertainty in Visitation Projections

NPS estimates of PWC use in 2002 and non-PWC use in the years 2002 through 2012 are based on a number of assumptions. In addition, a variety of unpredictable circumstances could affect visitation in a particular year. In general, visitation to LAME in a specific year will depend on many factors, including

- economic conditions,
- weather,
- natural resource conditions,
- national and state regulations that may affect PWC use or prices, and
- alternative recreational activities available.

In addition, as mentioned above, it is important to keep in mind that the benefits presented in this report are based on what NPS considers an upper bound on the number of park users that could receive benefits from PWC restrictions. To the extent that visitation to LAME by non-PWC users grows more slowly than assumed in this report, the benefits of PWC restrictions may be overstated.

It is also possible that publicity surrounding the proposed NPS PWC rules may have had an impact on PWC use in recent years. The rules were first proposed in 1998. However, according to the PWC sales data in Table 2-4, PWC sales began to decline in 1996. This suggests that other factors may be involved in the recent sales decline.

NPS identified the following additional uncertainties in the projections of baseline visitation:

- The estimate of 2001 PWC use represents NPS' best estimate of use.
- NPS projects growth in non-PWC visitation based on population growth in the surrounding counties. As discussed above, a number of factors could affect visitation in any one year or the trend in visitation over time. However, NPS believes that regional population growth, which should be related to economic conditions, generally represents the best available proxy for change in visitation. In the case of LAME, using recent regional population growth as a proxy for growth in park visitation may overstate visitation growth. This park is in the unique position of being located in one of the fastest growing regions of the U.S., but visitation growth has not kept pace with population increases in recent years.
- The change in PWC visitation between 2001 and 2002 is estimated using national data on PWC ownership. This measure is only an approximation for the trend in LAME PWC use.
- NPS makes assumptions about the number of PWC users who will return in the future following the ban. These assumptions represent our best estimate, but the actual

percentage of PWC users that continue to visit the park may be higher or lower.

2.3 ALTERNATE LOCATIONS FOR PWC USE NEARBY

Opportunities for PWC use in areas near LAME are extremely limited. Lake Havasu and the Colorado River below Davis Dam are adjacent to Lake Mojave, allow PWC use, and are within a 2-hour drive of the region. Glen Canyon National Recreation Area (GLCA) may be an alternate destination for PWC owners currently using LAME; however, it is approximately 300 miles to the northeast and NPS is reviewing future PWC access there.

2.4 OTHER MAJOR SUMMER ACTIVITIES IN LAME

Water-based summer recreation activities in LAME include swimming, boating, waterskiing, rafting, kayaking, canoeing, and fishing. Commercial lake services provide lake and charter tours of portions of Lake Mead and rafting trips from Hoover Dam to Willow Beach on the northern extent of Lake Mohave. Incidental business permit holders also provide rentals of canoe and kayaks.

Land-based activities at LAME include hiking, backpacking, picnicking, camping, biking, scenic drives, guided tours, bird watching, nature viewing, and visiting historic sites.

The developed areas of LAME offer services, including boat rentals, marina slips, dry boat storage, restaurants, campgrounds, and lodging facilities.

2.5 NATURAL RESOURCES AND LIKELY ECOLOGICAL IMPACTS OF PWC USE IN PARK

NPS is mandated to preserve the natural resources of LAME, including the resources of the stream and lake communities. Although the reservoirs were created only after constructing Hoover and Davis Dams, they include important aquatic and riparian habitat and support a variety of fish, wildlife, and vegetative species.

NPS performed an impairment analysis to assess the impacts to park resources under the various proposed management alternatives. The impact analysis focused on the potential for impacts to natural resources from the proposed facility expansions, the recreational opportunity classifications and zoning on Lakes Mead and Mohave, and from the continued visitor use of the recreation area. Details of this analysis, including guiding regulations and policies as well as methodologies and assumptions, are described in the EIS for LAME (NPS, 2002a).

Conclusions specific to potential impacts associated with PWC use under each proposed alternative are presented below. Other aspects of the alternatives, such as facility expansion, increased visitor use, and increased litter and sanitation problems are beyond the scope of this analysis but are presented in the EIS (NPS, 2002a). For the purposes of the analyses in this report, a ban on PWC use is considered the baseline condition to which each of the alternatives is compared, because PWC will be prohibited after April 10, 2003 if no regulation allowing their use were passed.

Generally speaking, the resulting impacts of PWC use on natural resources from implementing Alternative C are not expected to differ significantly from those associated with Alternative B because the prohibited use zones of both alternatives are relatively remote and are therefore less accessible to PWC users than the areas where PWC use would be permitted.

2.5.1 Water Quality

Most research on the effects of PWC use on water quality focuses on the impacts of two-stroke engines and assumes that impacts caused by these engines also apply to the PWC powered by them. The typical conventional (i.e., carbureted) two-stroke PWC engine intakes a mixture of air, gasoline, and oil into the combustion chamber; expels exhaust gases from the combustion chamber; and discharges as much as 30 percent of the unburned fuel mixture as part of the exhaust (California Air Resources Board, 1999). At common fuel consumption rates, an average 2-hour ride on a PWC may result in the discharge of 3 gallons (11.34 liters) of fuel into the water (VanMouwerik and Hagemann, 1999).

Contaminants released into the environment because of PWC use include those present in the raw fuel itself and those that are formed during its combustion. Fuel used in PWC engines contains many hydrocarbons (HCs), including volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, and xylene (collectively referred to as BTEX) and methyl tertiary butyl ether (MTBE). Unburned PWC fuel does not contain appreciable levels of polycyclic aromatic hydrocarbons (PAHs), but several PAHs are formed as a result of its combustion (i.e., phenanthrene, pyrene, chrysene/benzo(a)pyrene, and acenapthylene) (VanMouwerik and Hagemann, 1999). Other HCs that are not present in PWC fuel but are by-products of incomplete combustion include formaldehyde, acetaldehyde, diesel particulate matter (PM), and 1,3-butadiene (EPA 1994).

Unburned fuel and combustion by-products are released to the environment in PWC exhaust. Because of differences in chemical and physical characteristics, BTEX released into the water readily transfers from water to air, whereas most PAHs and MTBE do not. Therefore, water quality issues associated with BTEX in the water column are less critical than those associated with PAHs and MTBE (VanMouwerik and Hagemann, 1999).

Compounds released in water as a result of PWC use are known to cause adverse health effects to humans and aquatic organisms. Exhaust emissions from two-stroke engines have been specifically shown to cause toxicological effects in fish (Tjarnlund et al., 1995, 1996; Oris et al., 1998). Sunlight can further increase the toxic effect of PAHs to aquatic organisms (Mekenyan et al., 1994; Arfsten et al., 1996). Research evaluating the possible phototoxic effects of some PAHs to aquatic organisms has demonstrated that toxicity may vary due to a number of factors, including length of exposure; turbidity, humic acid, and organic carbon levels; the location of the organism relative to the surface of the water or the sediment; and weather/PAH fate issues (NCER, 1999). For instance, increased turbidity or organic carbon tended to reduce toxicity, increasing the length of exposure tended to increase toxicity, and proximity to the surface might increase toxicity (i.e., shallow waters).

New PWC engines, including direct-injected two-stroke engines and four-stroke engines, will decrease the amount of unburned fuel that escapes with PWC exhaust and will result in decreases in

emissions (VanMouwerik and Hagemann, 1999). As a result of EPA's 1996 rule requiring cleaner-running spark-ignited marine engines,[8] a 50 percent reduction of current HC emissions from these engines is expected by 2020, and a 75 percent reduction in HC emissions is expected by 2025 (EPA, 1996b).

Current (Pre-Ban) Water Quality Conditions at LAME

LAME has adopted water quality standards for both recreational and drinking water uses. These criteria include EPA's National Recommended Water Quality Criteria for Priority Toxic Pollutants and State of Nevada Water Quality Criteria. A more detailed overview of these water quality criteria is presented in the EIS (NPS, 2002a).

Potential threats to water quality within Lakes Mead and Mohave from sources other than PWC include external sources of contamination, such as Las Vegas Wash and the Virgin and Muddy Rivers, and internal sources, such as park wastewater treatment, human sanitation, and gasoline and oil from boats. During periods of peak use moderate impacts to water quality in high-use areas (i.e., Horsepower Cove, Saddle Cove, and Government Wash on Lake Mead, and Arizona and Nevada Telephone Coves, Katherine Landing and Cabinsite Point on Lake Mohave) may result from gasoline and gasoline additives introduced to lake waters from using conventional, inefficient two-stroke engines and from spillage during refueling[9] of vessels on the water (NPS, 2002a). The impact on water quality from these compounds may be mitigated by dilution in the volume of water in Lakes Mead and Mojave and by the high volatility of many of the compounds associated with motor vessels. U.S. Geological Survey (USGS) water quality studies have shown that concentrations of PAHs and other gasoline and motorboat emission compounds in surface waters of Lakes Mead and Mohave are below maximum contaminant levels for drinking water and are below the lowest observable effect levels for aquatic

[8] In 1996, EPA promulgated a rule to control exhaust emissions from new spark-ignition marine engines, including outboards and PWC. Emission controls provide for increasingly stricter standards beginning in model year 1998, with all PWC manufactured after 2006 required to be EPA emissions compliant (i.e., to reduce HC emissions by 75 percent from unregulated levels) (EPA, 1996b).

[9] According to observations by park staff, the primary user group to refuel on the water is PWC users.

life (NPS, 2002a).[10] Under baseline conditions of a PWC ban, impacts to water quality from PWC are considered non-existent.

Potential Impact of PWC Use on Water Quality Under the Proposed Alternatives

Alternative A (No Action). No impacts to water quality from PWC would occur within LAME under a ban. Although water quality impacts from PWC would be non-existent, unburned fuel and combustion by-products could still enter the lakes from other motorized vessels and from other sources such as run-off and fuel spills and from the Las Vegas Wash.

Alternative B: PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of a 100-Foot Shoreline Wakeless Zone and Ban on Conventional Two-Stroke Engines within One Year of Implementation of the LMP. Historically, PWC comprised approximately 35 percent of the boats on the water at any one time during the summer months (NPS, 2002a). In the winter months, PWC use drops to 10 percent of boats at any one time (Holland, 2002). Therefore, relative to a ban on PWC use at LAME, Alternative B would be expected to have some negative impacts on water quality, particularly outside the primitive and semiprimitive areas where PWC would be prohibited. However, as noted above, water quality studies (conducted while PWC were permitted) have shown that concentrations of PAHs and other gasoline and motorboat emission compounds in surface waters of Lakes Mead and Mohave are below maximum contaminant levels for drinking water and are below the lowest observable effect levels for aquatic life (NPS, 2002a). As well, the ban of conventional two-stroke engines from the recreation area within 1 year of the record of decision for the LAME environmental impact statement would mitigate impacts to water quality by reducing emissions, particularly in high-use coves where concentrated use has occurred. However, impacts associated with offshore refueling spills would likely continue in areas where PWC access is permitted, although increased boater education may help reduce the incidence of these spills.

[10] PWC were among motorized vessel permitted on Lakes Mead and Mohave when water quality studies were conducted.

Alternative C (the Modified Preferred Alternative): PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of a 200-Foot Shoreline Wakeless Zone and Ban on Noncompliant Two-Stroke Engines after 2012. Impacts are expected to be similar to Alternative B, although any mitigation of water quality from reduced emissions is likely to be gradual as manufacturers meet EPA requirements to improve the efficiency of engines by the year 2006 and conventional engines are replaced with direct-injected two-stroke or four-stroke models. Therefore, any mitigation of water quality impacts would occur over a longer time frame than Alternative B, because regulations would require EPA-compliant engines after 2012.

Alternative D: Continued PWC Use Except where Prohibited by Shoreline Zoning or for Safety Reasons, Implement a 300-Foot Shoreline Wakeless Zone. Impacts to water quality are expected to be similar to those identified for Alternatives B and C, although no areas are identified as primitive and semiprimitive zones where PWC would be prohibited. Mitigation of any impacts to water quality from reduced emissions are likely to be gradual as manufacturers meet EPA requirements to improve the efficiency of engines by the year 2006 and conventional engines are replaced with direct-injected two-stroke or four-stroke models, although the effect of the regulation is not expected to be fully realized in LAME until after the year 2025. Emissions and refueling spills still would be likely to add unburned fuel and combustion by-products to the waters in high use area, thereby reducing the water quality in these areas, although boater education may help reduce the incidence of these spills.

Moreover, this alternative also includes promoting increased visitation and boating. If growth in use occurs, impacts associated with PWC would increase similarly; however, this impact would likely be moderated by reductions in emissions with the introduction of the EPA-compliant machines and increased boater education.

2.5.2 Air Quality

Air quality and visibility can be affected by emissions from two-stroke engines such as PWC motors. Emissions from PWC in

national parks are one of many potential (albeit, relatively small) sources of these air quality and visibility impairments.

Recreational marine engines, including PWC and outboard motors, contribute approximately 30 percent of national nonroad engine emissions and are the second largest source of nonroad engine HC emissions nationally (EPA, 1996a). According to the results of a 1990 inventory of emissions in California, watercraft engines were estimated to account for 141 tons of smog-forming reactive organic gases (ROG), 1,063 tons of carbon monoxide (CO), and 31 tons of nitrogen oxides (NOx) emitted per day (Kado et al., 2000). A study comparing emissions from conventional and direct-injected two-stroke engines with four-stroke engines found that the new four-stroke engine has considerably lower emissions of PM, PAHs, and genotoxic activity (Kado et al., 2000). Based on a comparison with a typical 90-horsepower engine it is estimated the ban of conventional two-stroke engines would result in a four-fold decrease in smog-forming pollution per engine (VanMouwerik and Hagemann, 1999).

Although PWC engine exhaust is usually routed below the waterline, a portion of the exhaust gases pollutes the air. Up to one-third of the fuel delivered to conventional two-stroke engines goes unburned and is discharged as gaseous HCs; the lubricating oil is used once and is expelled as part of the exhaust; and the combustion process results in emissions of air pollutants such as HCs (including VOCs [e.g., BTEX and MTBE] and PAHs), NOx, PM, and CO (Kado et al., 2000). PWC also contribute to the formation of ozone (O_3) in the atmosphere, which is formed when HCs react with NOx in the presence of sunlight (EPA, 1993). (See Section 2.5.1 for further discussion of burned and unburned constituents of PWC emissions.)

These compounds are known to cause adverse effects to both human and plant life. They may adversely affect park visitor and employee health, as well as sensitive park resources. O_3 causes respiratory problems in humans, including cough, airway irritation, and chest pain during inhalations. O_3 is also toxic to sensitive species of vegetation. It causes visible foliar injury, decreases plant growth, and increases plant susceptibility to insects and disease (EPA, 1993).

CO can interfere with the oxygen-carrying capacity of blood, resulting in lack of oxygen to tissues. NOx and PM emissions associated with PWC use can also degrade visibility. Adverse health effects have been associated with airborne PM, especially less than 10 μm aerodynamic diameter (PM_{10}) (Kado et al., 2000). NOx also contributes to acid deposition effects on plants, water, and soil.

Current (Pre-Ban) Air Quality Conditions at LAME

NPS has monitored the visibility at LAME using a teleradiometer and camera to establish baseline air quality information and is currently monitoring O_3 levels within the recreation area to establish baseline data. In 2001 and 2002 ozone was measured at Northshore, Overton Arm, and Katherine Landing in Arizona. According to these data, ozone levels in the park are less than the national standards (NPS, 2002a). LAME is designated as a Class II air quality area under the Clean Air Act. The air quality of the Lake Mead region is generally good; however, some degradation of air quality is evident throughout the lower elevations of the recreation area.

The sources of air pollution originate primarily from outside the park and can concentrate in the park, especially during periods of atmospheric inversion, causing visible smog. Currently the major sources of air pollutants within or adjacent to LAME include emissions from the Mohave power-generating plant near Laughlin, Nevada; emissions from motor vehicles from the Las Vegas valley and other urban areas; fugitive dust from gravel and gypsum quarries; disturbed lands and construction activities; and emissions from other power-generating plants in the region. Localized impacts to LAME air quality from fuel odors and smoke from exhaust are apparent around the marinas and in areas where concentrated boating occurs, such as coves. However, LAME air quality does not exceed national ambient air quality standards for PM_{10} or CO with the current use of inefficient two-stroke engines and other motorized vessels (NPS, 2002a).[11] Under baseline conditions of a PWC ban, impacts to air quality from PWC are considered non-existent.

[11] PWC were among motorized vessel permitted on Lakes Mead and Mohave when air quality studies were conducted.

Potential Impact of PWC Use on Air Quality Under the Proposed Alternatives

Alternative A (No Action). No impacts to air quality from PWC would occur within LAME under a ban. However, other motorized use would continue to contribute emissions that may affect air quality, albeit historically at levels below Clean Air Act standards.

Alternative B: PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of a 100-Foot Shoreline Wakeless Zone and Ban on Conventional Two-Stroke Engines within One Year of Implementation of the LMP. As previously indicated, PWC comprised approximately 35 percent boat use during summer months and 10 percent of boats in the winter. Therefore, relative to a ban on PWC use at LAME, Alternative B could have some impact on air quality, particularly outside the primitive and semiprimitive areas where PWC would be prohibited. However, as noted above, although air quality standards historically have not been exceeded at LAME, and there is no evidence that PWC use contributed substantively to smog during periods of atmospheric inversions, restrictions on the use of noncompliant two-stroke engines by motorized vessels could mitigate any contribution of PWC to air quality, particularly in high-use areas. Reductions in emissions could also mitigate any impacts to air quality by reducing smoke and gasoline-type odors.

Alternative C (the Modified Preferred Alternative): PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of a 200-Foot Shoreline Wakeless Zone and Ban on Noncompliant Two-Stroke Engines after 2012. Impacts are expected to be similar to Alternative B, although any mitigation of impacts to air quality from reduced emissions are likely to be gradual as manufacturers meet EPA requirements to improve the efficiency of engines by the year 2006 and conventional engines are replaced with direct-injected two-stroke or four-stroke models. Therefore, any mitigation of impacts to air quality would likely happen more slowly because regulations would require EPA-compliant engines only after 2012.

Alternative D: Continued PWC Use Except where Prohibited by Shoreline Zoning or for Safety Reasons, Implement a 300-Foot Shoreline Wakeless Zone. Impacts to air quality are expected to be similar to those identified for Alternatives B and C, although no areas are identified as primitive and semiprimitive zones where

PWC would be prohibited. Mitigation of any impacts to air quality from reduced emissions are likely to be gradual than in Alternatives B or C, as manufacturers meet EPA requirements to improve the efficiency of engines by the year 2006 and conventional engines are replaced with direct-injected two-stroke or four-stroke models.

Moreover, this alternative also includes promoting increased visitation and boating. If growth in use occurs, impacts associated with PWC would increase similarly; however, this impact would likely be moderated by reductions in emissions with the introduction of the EPA-compliant machines.

2.5.3 Soundscapes

One aspect of experiencing the resources in national parks is the ability to hear the sounds associated with its natural resources, often referred to as "natural sounds" or "natural quiet." Natural quiet generally includes the naturally occurring sounds of winds in the trees, calling birds, and the quiet associated with still nights. "Noise" is defined as unwanted sound. Sounds are described as noise if they interfere with an activity or disturb the person hearing them.

PWC emit up to 105 dB per unit at 82 feet, which may disturb park users (visitors and residents). NPS has established a noise limit of 82 dB at 82 feet. Noise from PWC may be more disturbing than noise from a constant source at 90 dB because of rapid changes in acceleration and direction of noise (EPA, 1974) and their ability to be driven in shallow water close to the shoreline. However, the newer, compliant models of PWC may be up to 50 to 70 percent quieter than the older models (PWIA, 2002).

Current (Pre-Ban) Soundscape Conditions at LAME

Background noise levels at LAME are influenced by boats, traffic, and airplanes. Although specific background noise studies are not available for LAME, given its setting, it is assumed that the soundscape ranges from active urban in the developed areas and high-use zones on the lakes to quiet rural in the outlying areas of the lake where use levels are considerably lower.

On a typical summer weekend approximately 4,000 boats operate at any one time on the waters of Lakes Mead and Mohave; at peak

use this number exceeds 5,000 boats. During high-use times the sound of boats can be continuous in the urban park and urban natural zones. Boat noise is also noticeable in the rural natural zones during periods of high boating activity, but there are extended periods when boating noise is not noticeable in these areas. Currently, there are no areas where motorized boating is prohibited, so there are no existing areas on the lakes where visitors can go to escape boating-related sounds. Under baseline conditions of a PWC ban, impacts to the soundscape from PWC are considered non-existent. Potential impacts of noise on wildlife are discussed in Section 2.6.5.

Potential Impact of PWC Use on Soundscape Under the Proposed Alternatives

Alternative A (No Action). No impacts to the soundscape from PWC would occur within LAME under a ban. However, it is likely that boating noise would replace PWC noise in high-use cove areas as the number of boats allowed on the water are authorized to increase under this alternative.

Alternative B: PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of a 100-Foot Shoreline Wakeless Zone and Ban on Conventional Two-Stroke Engines within One Year of Implementation of the LMP. As previously indicated, PWC comprised approximately 35 percent boat use during summer months and 10 percent of boats in the winter. Therefore, relative to a ban on PWC use at LAME, Alternative B could have some impact on the soundscape, particularly outside the primitive and semiprimitive areas where PWC would be prohibited. However, the immediate ban of conventional two-stroke engines would reduce noise from motorized vessels, including PWC, using these engines parkwide. Noise would be a major part of the experience in the urban park and urban natural environment, as well as in the marina areas, because of the high use levels in these areas by other motorized vessels. The 100-foot wakeless zone around the shoreline would mitigate shoreline noise associated with PWC. However, frequent changes in pitch and loudness caused by rapid acceleration, deceleration, and change of direction would likely be noticeable to other recreationists. Although most visitors

to LAME have some expectation of noise from watercraft, some visitors could be negatively affected by noise from PWC.

Alternative C (the Modified Preferred Alternative): PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of a 200-Foot Shoreline Wakeless Zone and Ban on Noncompliant Two-Stroke Engines after 2012. Impacts are expected to be similar to Alternative B, although any mitigation of impacts to the natural soundscape from reduced noise are likely to be gradual as manufacturers meet EPA requirements to improve the efficiency of engines by the year 2006 and noncompliant engines are replaced with direct-injected two-stroke or four-stroke models. Therefore, any reduction in noise associated with PWC due to the transition to EPA-compliant models would be slower. However, the 200-foot shoreline wakeless zone would extend the area of reduced shoreline noise relative to Alternative B.

Alternative D: Continued PWC Use Except where Prohibited by Shoreline Zoning or for Safety Reasons, Implement a 300-Foot Shoreline Wakeless Zone. Impacts to the natural soundscape are expected to be similar to those identified for Alternatives B and C, although no areas are identified as primitive and semiprimitive zones where PWC would be prohibited. In addition, the noise from motorized vessels would be reduced along the shoreline with the implementation of a 300-foot wakeless zone, although the noise would likely continue to be noticed by other recreationists. There would be no areas in LAME for visitors who want an experience with little or no human-generated noise. Thus, the impacts of Alternative D are likely to be greatest for those visitors.

Although there is no requirement under this alternative for EPA-compliant engines, it is anticipated that, as the industry standard for PWC engines changes, quieter engines would become the standard and overall PWC-associated noise would decrease. Therefore, mitigation of the impacts from PWC noise would occur with the transition to EPA-compliant models; however this is likely to be more gradual than under Alternatives B and C.

2.5.4 Wildlife and Wildlife Habitat

PWC may affect wildlife by interrupting normal activities, inducing alarm or flight responses, causing animals to avoid habitat, and

potentially affecting reproductive success. These effects are thought to be caused by a combination of PWC speed, noise, and ability to access sensitive areas, especially in shallow water (WDNR, 2000). PWC potentially can access sensitive shorelines and disrupt riparian habitats critical to wildlife. When run in very shallow water, PWC can disturb the substrate, including aquatic plants, benthic invertebrates, and, at certain times of year, fish breeding and nursery areas. Furthermore, water quality degradation caused by PWC can affect migratory avian species in the area.

Waterfowl and nesting birds may be particularly sensitive to PWC because of their noise, speed, and unique ability to access shallow water. This may force nesting birds to abandon eggs during crucial embryo development stages, keep adults away from nestlings, thereby preventing them from defending the nest against predators, and flush other waterfowl from habitat, causing stress and associated behavior changes (WDNR, 2000; Burger, 1998; Rodgers and Smith, 1997).

Current (Pre-Ban) Wildlife and Wildlife Habitat Conditions at LAME

The inflow areas of Lake Mead, including the inflow of the Virgin and Muddy Rivers on the north end of the Overton Arm and the Colorado River inflow at Pearce Ferry, have habitat of particular importance. These areas resemble stream riparian and stream communities, with vegetation such as willows, cottonwood, sedges, and rushes. These areas provide excellent habitat to a variety of bird species including the willow flycatcher and several species of shorebirds, herons, and egrets. In addition to these inflow areas, portions of the shoreline can provide habitat to other rare or sensitive species. Under baseline conditions of a PWC ban, impacts to wildlife and wildlife habitat from PWC are considered non-existent.

Mammals. Up to 55 species of mammals may occur in LAME, many of them nocturnal (see http://www.nps.gov/lame/mammals.html for a full species list). The Arizona river otter, beavers, raccoons, and other wildlife species have been reported to occur within the riparian areas. Bighorn sheep are also found within LAME and may access the shoreline areas (NPS, 2002a).

Birds. More than 240 bird species have been recorded in LAME (for a complete species list, see http://www.nps.gov/lame/birds.html). Some of the more sensitive species that exist and nest in the recreation area include the Southwestern willow flycatcher and the peregrine falcon, as well as blue grosbeaks, great blue herons, and Clark's grebes. The recreation area also receives potential use by vermilion flycatchers and yellow-billed cuckoos.

The creation of Lakes Mead and Mohave provided bodies of water that attracted many kinds of water and shore birds. The vegetation that developed around the lakes provided foraging grounds for many insectivorous birds. Because of the summer heat at LAME, most of the birds in the region occur during the fall, winter, and spring. In summertime, many of these birds migrate northward to milder climates or they may nest in nearby mountains.

The nesting season for neotropical migrants (e.g., Southwestern willow flycatcher, blue grosbeaks) is May to September. However, many birds, like the herons, start nesting earlier. Therefore, for these species, the primary nesting season directly correlates to the high visitor use season. Park biologists have noted through field observations that bird species can be disturbed from the operation of motorized vessels, particularly in shallow areas and inflow regions where nesting sites may be disturbed and along specific shoreline areas of Lake Mohave where native vegetation exists. The primary observed disturbance is flushing from nesting sites. Grebes (especially Clark's grebes) and Southwestern willow flycatchers are known to nest in portions of LAME. Grebes build floating nests and the Southwestern willow flycatchers sometimes build nests directly over the water. Wakes may damage these nests through flooding or from physical disturbance.

Fish. With the fluctuation of lake levels, shoreline vegetation can provide cover, once it is inundated, for fish species. The lakes support a number of fish species, including game, nongame, and endemic fish species. Nongame fish species in the reservoirs include carp, and game fish species include largemouth bass, striped bass, catfish, crappie, and blue gill. Rainbow trout are stocked in selected areas of both reservoirs. Base productivity for each of the reservoirs is low, in part due to nutrient deficiencies attributable to the creation of Glen Canyon Dam. Game fish species have become dependent on a single prey species, the

threadfin shad, and rainbow trout are becoming increasingly significant as prey species for striped bass.

Although concentrations of motorized vessel-associated contaminants in Lake Mohave have not been recorded at levels that impair the health of the aquatic system, the long-term effects on endemic fish are not known. It is likely that the short flushing cycles of the lakes and the volume of the lakes dilute these chemicals and reduce any potential impacts to the aquatic inhabitants.

Reptiles and Amphibians. Approximately 45 reptile and 10 amphibian species occur in LAME (for a complete species list see http://www.nps.gov/lame/reptiles.html).

Plants. LAME receives less than 6 inches of rain annually, and it is home to many desert and riparian plant species (for a complete list of plants see http://www.nps.gov/lame/plants.html). The primary habitats of concern for this analysis occur in the vicinity of Lakes Mead and Mohave and their tributaries and are the inflow areas of Lake Mead, including the Virgin and Muddy River inflows on the north end of the Overton Arm and the Colorado River inflow at Pearce Ferry. These areas resemble stream riparian and stream communities, with vegetation such as willows, cottonwood, sedges, and rushes and provide excellent habitat to a variety of bird species, including the willow flycatcher, several species of shorebirds, herons, and egrets (NPS, 2002a).

Two sensitive plant species, the sticky buckwheat and the three-sided milk-vetch, can occur in the sandy soils along the shoreline of Lake Mead. However, the majority of the shoreline in the recreation area contains nonnative salt cedar (*Tamarix* spp.), with relatively few areas supporting native vegetation. Fluctuating water levels along the shoreline make restoration of vegetation communities impossible in most situations. However, in selected areas, salt cedar has been removed and native trees, such as willow and cottonwood, have been transplanted in an attempt to re-establish the native riparian habitat.

The primary impact to riparian and shoreline species in LAME is associated with fluctuating water depths. Aquatic vegetation may be exposed to contamination for motorized vessels. There are limited shallow areas at LAME and there is no evidence of

phototoxicity related to PAHs or other damage to submerged aquatic vegetation.

Potential Impact of PWC Use on Wildlife Habitat Under the Proposed Alternatives

Alternative A (No Action). No impacts to wildlife and wildlife habitat from PWC would occur within LAME under a ban. However, other motorized vessels would still be present and would continue to affect wildlife in all portions of Lakes Mead and Mohave.

Alternative B: PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of a 100-Foot Shoreline Wakeless Zone and Ban on Conventional Two-Stroke Engines within One Year of Implementation of the LMP. Relative to a ban on PWC use at LAME, Alternative B could have some impact on wildlife and wildlife habitat, particularly outside the primitive and semiprimitive areas where PWC would be prohibited. However, according to NPS, impacts to wildlife and wildlife habitat from previous PWC activity throughout LAME are limited. There is some evidence that birds may be flushed from their nests and, to the extent that PWC were present in the vicinity of other wildlife and fish, there may have been some flight or stress responses as described above. There have been no known impacts to mammals, reptiles, amphibians, or plant species as a result of PWC use. As well, there has been no evidence that physical disturbance from PWC affected fish reproductive activities although PWC may have been active in LAME at some times of the year that fish are spawning.

The restriction of PWC from the semiprimitive and primitive areas, including sensitive inflow areas, would mitigate any impacts to wildlife located there, primarily birds and waterfowl. As well, the wakeless zone would help to mitigate impacts of PWC to wildlife and wildlife habitat in these areas.

Sensitive aquatic resources may continue to be exposed to non-PWC stressors such as fuel contamination from other motorized vessel use, run-off, fuel spills, and the Las Vegas Wash.

Alternative C (the Modified Preferred Alternative): PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of

a 200-Foot Shoreline Wakeless Zone and Ban on Noncompliant Two-Stroke Engines after 2012. Under this alternative, impacts would be comparable to Alternative B, although shoreline protection would extend to 200-feet.

Alternative D: Continued PWC Use Except where Prohibited by Shoreline Zoning or for Safety Reasons, Implement a 300-Foot Shoreline Wakeless Zone. Impacts to wildlife are expected to be similar to Alternatives B and C, although no areas are identified as primitive and semiprimitive zones where PWC would be prohibited. Although historic PWC use in inflow areas is low, this alternative also includes promoting increased visitation and boating it is anticipated that use throughout the recreation area will increase gradually over time. Breeding animals, primarily birds, present in these inflow areas during particularly vulnerable life stages, including migration and winter, may be increasingly affected as a result of this. Therefore, impacts to wildlife and wildlife habitat may be greater than in Alternatives B and C. However, impacts to wildlife near the shoreline will be mitigated by the 300-foot shoreline wakeless zone proposed to be implemented in the park.

2.5.5 Threatened and Endangered Species and Special Concern Species Habitat

PWC may affect threatened, endangered, and special species of concern in the same manner they affect wildlife such as by disrupting or degrading the quality of habitat, interrupting normal activities, inducing alarm or flight responses, causing animals to avoid habitat, and potentially affecting reproductive success. Under baseline conditions of a PWC ban, impacts to species of potential concern from PWC are considered non-existent.

Current (Pre-Ban) Conditions of Threatened, Endangered, and Special Concern Species at LAME

Fish. Two endemic fish species listed as federally endangered species remain in Lakes Mead and Mohave, despite the alteration of the riverine environment as a result of the construction of the dams. The razorback sucker (*Xyrauchen texanus*) occurs in both lakes, with the largest remaining population in the Colorado River system inhabiting Lake Mohave. The bonytail chub (*Gila elegans*) exists in Lake Mohave. Lakes Mead and Mohave have been designated as

critical habitat for the razorback sucker, and Lake Mohave has been designated as critical habitat for the bonytail chub. The humpback chub (*Gila cypha*) and the Colorado squawfish (*Ptychocheilus lucius*) are federally endangered species that potentially could occur within the recreation area, although these species are considered extirpated within the recreation area (NPS, 2002a).

The Virgin River and its 100-year floodplain are proposed critical habitat for two additional fish listed as endangered species: the Virgin River chub (*Gila seminuda*) and the woundfin (*Plagopterus argentissimus*). The Virgin River chub inhabits the Virgin and Muddy Rivers and the woundfin is found in the Virgin River, and both could be found within the recreation area.

The impacts of recreation on the lakes, including boating (and PWC use), on razorback suckers and bonytail chub, have not been thoroughly studied within the recreation area. Although concentrations of motorized vessel-associated contaminants in Lake Mohave have not been recorded at levels that impair the health of the aquatic system, the long-term effects on endemic fish are not known. It is likely that the short flushing cycles of the lakes and the volume of the lakes dilute these chemicals and reduce any potential impacts to the aquatic inhabitants.

Razorback suckers spawn from January through early April and occupy specific shoreline areas at this time. It is likely that they are more sensitive to disturbance during this period. Biologists have noted that using motorized vessels in and around the razorback sucker spawning aggregations along the shorelines of Lake Mohave causes a great deal of turmoil (NPS, 2002a). Passing watercraft interrupt spawning, displace staging and spawning fish, disturb substrates, and generally bother the fish, affect their behavior, and disturb their habitat. This is especially a concern where fish use shallower shoreline areas where boat motors and their noises and turbulence are in close proximity to the fish. The same type of disturbances are likely for bonytail chub, which spawn later in the spring into May.

Birds. Several listed or sensitive bird species use the lake and riparian areas. The threatened bald eagle (*Haliaeetus leucocephalus*) is a winter visitor to the recreation area and can be found in large trees and cliffs along the shoreline of both lakes.

There is no evidence that PWC use adversely affects bald eagles. Bald eagles are present within the recreation area during periods of the lowest visitor use and have not used the areas for nesting.

Peregrine falcons, a sensitive species, nest on cliff sites adjacent to Lakes Mead and Mohave away from the developed zones. According to surveys, in the past 5 years their numbers have increased within their habitat zones throughout the recreation area. Boating activities, including PWC, have not been shown to adversely affect peregrine falcons or their habitat.

The endangered Southwestern willow flycatcher (*Empidonax traillii extimus*) has been observed along the shoreline areas of Lake Mohave and in the inflow areas of the Virgin and Muddy Rivers. Potential habitat for the endangered Yuma clapper rail (*Rallus longirostris yumanensis*) exists in the recreation area at the inflow areas of the Muddy and Virgin Rivers, at Las Vegas Wash upstream from the recreation area, and in the southern portion of the park near Davis Dam. Yuma clapper rails have been recorded on the northern Overton Arm at the Muddy river inflow area.

Western snowy plover are migratory visitors to the recreation area. Biologists have seen plovers along Lake Mohave in the spring and fall, though they are a rare transient. Potential habitat for the Western snowy plover is located at the Virgin and Muddy River inflow areas, the Pearce Delta, and Las Vegas Wash.

The sensitive California brown pelican is considered a transient visitor to LAME, and no nesting activities are known to occur within the recreation area.

Reptiles and Amphibians. The recreation area provides important habitat for the threatened desert tortoise (*Gopherus agassizii*). This habitat is generally in the desert scrub away from the shoreline areas. The relict leopard frog (*Rana onca*) is a species of concern in the recreation area. This species was once thought of as extinct but has been recently found in certain springs within the recreation area.

Plants. There are no listed threatened or endangered plant species in the recreation area, although a number of sensitive species could be found along the shoreline and below high water levels. The Las Vegas bearpoppy (*Arctomecon californica*), the sticky ringstem

(*Anulocaulis leiosolenus*), the three corner milkvetch (*Astragalus geyeri* var. *triquetrus*), and the sticky buckwheat (*Eriogonum viscidulum*) are sensitive plant species that have been found around Lake Mead, below the high water level.

For a complete listing of federally listed threatened, endangered, or sensitive species that are found or could be found in the recreation area, see Appendix E of the EIS (NPS, 2002a).

Potential Impact of PWC Use on Threatened and Endangered Species Under the Proposed Alternatives

Alternative A (No Action). No impacts to species of potential concern would occur from PWC within LAME under a ban. Impacts from other motorized vessels may continue.

Alternative B: PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of a 100-Foot Shoreline Wakeless Zone and Ban on Conventional Two-Stroke Engines within One Year of Implementation of the LMP. Relative to a ban on PWC use at LAME, Alternative B could have some impact on species of concern, particularly outside the primitive and semiprimitive areas where PWC would be prohibited. However, there is no historic evidence that any of the species identified above have been affected by PWC use in the LAME. Surveys have observed flycatchers in the shoreline areas of Lake Mohave and in the inflow areas of the Virgin and Muddy Rivers during nesting periods, and they could be using shoreline and riparian areas for nesting. Because nesting periods coincide with the peak recreational use period (June and July) for both lakes, the potential exits for willow flycatcher population at LAME to be adversely affected by PWC use in the inflow areas. However, Alternative B does not permit PWC in semiprimitive and primitive areas, including sensitive inflow areas, and implements a 100-foot wakeless zone. Thus, any potential impacts to the Southwestern willow flycatcher should be minimized.

Alternative C (the Modified Preferred Alternative): PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of a 200-Foot Shoreline Wakeless Zone and Ban on Noncompliant Two-Stroke Engines after 2012. Under this alternative, impacts would be comparable to Alternative B.

Alternative D: Continued PWC Use Except where Prohibited by Shoreline Zoning or for Safety Reasons, Implement a 300-Foot Shoreline Wakeless Zone. Under this alternative, PWC would not be restricted from sensitive inflow areas, and the potential exists for the willow flycatcher population at LAME to be adversely affected by PWC use. The 300-foot wakeless zone might mitigate any interactions between PWC and natural resources present in shoreline or near-shore areas.

2.5.6 Shorelines and Shoreline Vegetation

PWC use can potentially adversely affect the shoreline habitat including the shoreline, shoreline vegetation, and submerged aquatic vegetation (SAV) beds. Shoreline and shoreline vegetation are critical to the juvenile stages of fish and general overall habitat for a variety of aquatic organisms, including fish, shellfish, and waterfowl species. SAV beds are also critical to aquatic organisms. SAV beds reduce wave action, support nursery fish, provide protection from predators, stabilize sediment, and provide food for many species.

PWC can affect shoreline and shoreline vegetation because they are able to access areas where most other watercraft cannot go because of their shallow draft. As a result, PWC may land on the shoreline allowing visitors to access and disturb areas where sensitive plant species exist. In addition, wakes created by PWC may cause erosion and thus affect shorelines. Turbulence from boat propellers near the shoreline can also erode the shoreline by destabilizing the bottom (WDNR, 2000).

PWC use can also affect SAV by increasing turbidity, which may result in decreased sunlight available for SAV, may limit vegetation growth, and ultimately decrease water quality. PWC use in shallow water supporting SAV may reduce its value as important habitat for animals by redistributing the plants and organisms that use these grasses for habitat.

Current (Pre-Ban) Condition of Shorelines and Shoreline Vegetation at LAME

Riparian vegetation plays a critical role in the habitat within the recreation area at the inflow areas. These ecosystems around Lakes Mead and Mohave are adversely affected by the dramatic water-

level fluctuations and increased soil salinization. Stands of vegetation that are able to establish in the drawdown zone are often inundated and flooded once water levels rise or are lost when water levels rapidly decline. The dominant shoreline vegetation below the high water line around both lakes is nonnative tamarisk. Gooding's willow and cottonwoods have colonized the shoreline where the Virgin and Muddy Rivers meet the lakes. Similarly, Gooding's willows occur along the Colorado River inflow at Pearce Ferry. Lake Mead and Lake Mohave do not have sensitive grasses and SAV near the shoreline areas, except in the sensitive inflow areas. In addition, several rare or sensitive plant species are located below the high water line or within walking distance of the lake. These species could be directly affected by recreational use (i.e., tree cutting for firewood, trampling of small plants). These types of impacts are considered minor to moderate. Under a worse case scenario, they could cause a change in the plant community by altering the abundance, quantity, and quality over a localized area. Under baseline conditions of a PWC ban, impacts to species of potential concern from PWC are considered non-existent.

Potential Impact of PWC Use on Shoreline and Shoreline Vegetation Under the Proposed Alternatives

Alternative A (No Action). No impacts to shoreline vegetation would occur from PWC within LAME under a ban.

Alternative B: PWC Access Restricted in Primitive and Semiprimitive Areas and Ban on Noncompliant Two-Stroke Engines within One Year of Implementation of the LMP. Relative to a ban on PWC use at LAME, Alternative B could have some impact on wildlife and wildlife habitat, particularly outside the primitive and semiprimitive areas where PWC would be prohibited. Lake Mead and Lake Mohave do not have sensitive grasses and SAV near the shoreline areas, except in the sensitive inflow areas. In these areas turbidity and physical disturbance associated with PWC are the primary potential impacts, but there is no evidence that aquatic vegetation has been degraded as a result of historic PWC use. Moreover, Alternative B does not permit PWC in semiprimitive and primitive areas, including sensitive inflow areas, therefore no PWC-associated impacts to vegetation are expected under this alternative.

Establishing a100-foot wakeless area around the shoreline would mitigate possible erosional impacts, although these impacts have not been considered significant historically.

Alternative C (the Modified Preferred Alternative): PWC Access Restricted in Primitive and Semiprimitive Areas, Implementation of a 200-Foot Wakeless Zone and Ban on Noncompliant Two-Stroke Engines after 2012. Impacts from PWC would be similar to those described under Alternative B.

Alternative D: Continued PWC Use Except where Prohibited by Shoreline Zoning or for Safety Reasons, Implement a 300-foot Wakeless Zone. Under this alternative, PWC would not be restricted from sensitive inflow areas, and the potential exits for SAV at LAME to be adversely affected by PWC; however, as indicated above there is no evidence that aquatic vegetation has been degraded as a result of historic PWC use. The 300-foot wakeless zone might help to mitigate any potential erosional impacts.

2.6 ECONOMIC ACTIVITY IN THE SURROUNDING COMMUNITIES

NPS identified 19 PWC-related businesses in the vicinity of LAME that may be directly affected by any restriction on PWC use.

LAME is located near Las Vegas, the largest city in Nevada and one of the top tourist destinations in the world. Other cities and towns located in the LAME area include Boulder City and Henderson in Nevada and Bullhead City in Arizona. Tourism is an extremely important part of the local economy. In fact, Las Vegas has the highest percentage of business sales in tourist-intensive industries of any metropolitan area in the U.S. by a wide margin (Bram, 1995). However, PWC use in LAME makes an extremely small contribution to tourism-related revenues in the regional economy. NPS identified 10 PWC rental shops and nine PWC sales/service shops located in communities near LAME. Five PWC sales/service shops were identified in Las Vegas, NV; three in Bullhead City, AZ; and one in Henderson, NV. Three PWC rental shops were identified in Las Vegas; two in Bullhead City; two in Henderson; one in Overton, NV; one in Searchlight, NV; and one in Boulder City, NV.

NPS attempted to contact these businesses during January 2002 and successfully collected interview data from many of the firms. Based on comments received from these businesses, the vast majority of their customers rely on LAME as their primary destination for PWC

activity. PWC are sold year-round with the majority of the sales in the late spring/early summer. The dealerships reported that customers typically replace their PWC approximately every 3 years, on average, with newer models. Interview data suggest that the PWC dealerships, service centers, and rental shops near LAME have other sources of revenue besides PWC sales. Some of the PWC dealerships sold items such as motorcycles, boats (other than PWC), motor scooters, all-terrain vehicles (ATVs), trailers, generators, and outboard motors. In addition, some businesses offering PWC rentals had highly diversified revenue sources, offering camping and marina services as well as other boat rentals. Each firm contacted indicated that their business would be affected relative to pre-ban conditions under at least one of the alternatives. For Alternatives B and C, the dealerships interviewed estimated a wide range of PWC revenue losses ranging from zero to 100 percent. Under Alternative A, the no-action alternative, there was almost unanimous agreement that PWC revenue would fall by close to 100 percent relative to 2002 levels. Because the baseline is a ban on PWC use in LAME, this implies that Alternatives B, C, and D would each have large positive impacts on local businesses relative to baseline conditions by avoiding these declines in revenue that would otherwise occur.

In addition to businesses offering PWC sales and service or rental services, the proposed management alternatives could affect lodging establishments, restaurants, gas stations, and retail stores in the area. These establishments may be affected if the proposed restrictions lead to changes in visitation to the park and surrounding area. However, because PWC users constitute an extremely small fraction of visitors to the local area, which includes Las Vegas, it is very unlikely that there will be any measurable impacts on the region's tourist industry. For a more complete discussion of regional economic impacts, see Section 3. For a discussion of impacts to small businesses, refer to Section 5.

3 Economic Impact Analysis of Restricting PWC Use in Lake Mead National Recreation Area

Restrictions on PWC use in LAME may affect the local economy in several ways, including changes in park visitation, sales and profits of local businesses, local employment, and local and state sales tax revenue. Generally, allowing PWC use in the park is expected to increase economic activity in the areas surrounding the park. However, the incremental impacts are very small relative to the size of the local economy.

Authorizing continued PWC use in LAME is likely to have a positive economic impact on the surrounding area. The primary economic impacts associated with the proposed PWC management alternatives are the potential increases in the sales, profits, and employment of PWC sales and rental shops, restaurants, and other businesses that serve PWC users visiting LAME relative to baseline conditions. The incremental impact of each alternative depends in large part on the way that affected individuals and firms would have responded to a ban on PWC use in LAME. To the extent that affected local retailers are able to provide substitute products and services, they may have been able to reduce the negative impact of a ban on their profits. In addition, some former PWC users may have continued to visit LAME to participate in other recreational activities. It is also possible that visitation to LAME by non-PWC users would have increased following restrictions on PWC use if the restrictions made park visitation more enjoyable for this group of people. The more that producers and PWC users would have made adjustments to mitigate the negative impacts of the ban and non-PWC users would have increased their visitation, the smaller the

positive economic impacts of allowing continued PWC use in LAME.[1]

This section summarizes the incremental regional economic impacts associated with the proposed alternatives for restricting PWC use in LAME. The majority of the economic impacts are expected to be concentrated in the counties surrounding the park (Clark County, Nevada and Mohave County, Arizona). Thus, projected reductions in economic activity are compared to the size of the county economies to place the impacts in perspective.

3.1 SCENARIOS EXAMINED IN THIS REPORT

NPS estimates that about 337,500 visitors used PWC during 2001, accounting for about 4 percent of annual visitation.

As described in Section 2.2, PWC users account for a small fraction of total visitation to LAME. NPS estimates that approximately 337,500 visitors used PWC during 2001, accounting for only about 4 percent of annual visitation to LAME. Baseline visitation (i.e., with PWC being banned from LAME) was projected through 2012 using a starting point of average annual visitation over the last 5 years, 1997 to 2001. The proportion of visitors that used PWC in LAME during 2001 was estimated based on Holland (2002). Baseline visitation for non-PWC users was then assumed to increase at a rate equal to the average of the 1990-2000 annual population growth rates in the counties that surround LAME.[2] There is no future visitation to LAME by PWC users in the baseline because PWC use is banned under baseline conditions.

PWC users are expected to change their visitation to LAME in response to restrictions placed on PWC use. To estimate the magnitude of the resulting economic impacts, NPS constructed scenarios for the regulatory alternatives based on the available

[1] A decrease in expenditures for substitute activities in the LAME region relative to baseline conditions in response to allowing PWC use would partially offset any positive regional impacts associated with Alternatives B, C, and D. In addition, there may be reallocation of revenue among businesses.

[2] It would be preferable to use population projections rather than assuming that population growth would continue at historical levels. However, the Census Bureau only provides population projections at the state and national levels and NPS wanted to focus on the areas adjacent to the park. The population growth rate for this region has been extremely high in recent years relative to the U.S. overall. Growth in visitation to LAME has not been keeping pace with population growth, and it is unlikely that this region can maintain the growth rate of the last decade through 2012. Thus, the assumption that visitation will grow at this pace provides an upper bound on the benefits associated with a reduction in PWC use.

information. Under Alternative A, it is expected that there will be no incremental change in visitation because management of PWC in LAME would remain the same as under the baseline (i.e., no PWC use authorized within the park). Although there would be no PWC use in LAME under this alternative, it is likely that some former PWC users will continue to visit the LAME region to enjoy other recreational activities or use PWC in nearby substitute areas, although, as noted in Section 2.3, substitute areas for PWC use in the LAME area are extremely limited. For Alternatives B and C, it is expected that PWC users will increase their visitation to the park relative to baseline conditions, but that visitation would not return to the levels that would have prevailed in the absence of the ban due to additional location and engine-type restrictions under these alternatives. Under Alternative D, it is expected that visitation would be much higher than under the baseline, continuing at the values projected based on visitation in recent years prior to a ban on PWC use.

NPS assumes that people who continue to visit the LAME area will have the same spending patterns as under baseline conditions, except that some of them will resume renting PWC. It is possible that former PWC users would have continued to visit the park to engage in other summer recreational activities and would have increased expenditures on those activities. However, there is no information available on the amount these users might spend. Thus, reductions in this potential spending increase relative to the baseline are not included in the analysis. In addition, it is possible that the number of non-PWC users visiting LAME may decrease because potential increases in noise and pollution resulting from changes in PWC management in LAME could decrease their enjoyment of the area.[3] However, this potential impact was not included in the analysis because there are no data available on the extent to which this decrease in visitation by non-PWC users would occur.

NPS attempted to interview the sales and rental shops identified in the area to gain additional insight into the potential impacts on

[3]This could result from a decrease in the number of visitor-days for non-PWC users that have visited the park in the past and/or a reduction in visitation (relative to baseline) by people who have not visited the park in the past, but would have begun visiting if PWC use were restricted.

those businesses. The universe of affected entities was identified by visiting the LAME area and contacting potentially affected businesses. Because NPS conducted this analysis during January 2002, some of the PWC-related businesses in the area were closed. However, NPS was able to contact and interview many of the area firms providing PWC sales, service, and rentals. The PWC dealerships, service shops, and rental shops generally expressed some concern that any restriction on PWC use could cause a reduction in sales as a result of negative publicity. Thus, taking action to avoid a ban on PWC use in LAME could have a large positive incremental impact on area businesses. All of the sales and rental shops interviewed predicted very significant declines in sales under Alternative A relative to revenues in 2002, with up to 100 percent losses in PWC-related revenues between 2002 and 2003. Several shops indicated that sales have already fallen 20 to 30 percent because of a rumor that the park would ban PWC. Authorizing continued PWC use in LAME would have large positive impacts on local businesses compared with baseline conditions because the losses predicted under the no-action alternative would be avoided. These predicted impacts for local businesses are discussed in more detail in Section 5.

Based on information collected from local businesses and LAME park staff, scenarios were developed for each of the proposed regulatory alternatives. The four primary scenarios that were analyzed for LAME are summarized in Table 3-1. For Alternatives B, C, and D, NPS assumed that PWC use would be declining at a 1.45 percent annual rate in the absence of the ban based on recent national trends in PWC ownership (see Table 2-3). Because of the relatively limited availability of similar substitute recreational areas, it was assumed that 80 percent of the visitors projected to stop using PWC in LAME voluntarily would continue to visit for alternative recreational activities. This implies that the net reduction in baseline visitation by PWC users would be –0.29 percent per year (–1.45 percent *0.2) in the absence of new PWC regulations. These assumptions do not apply to Alternative A because there would be no PWC use in the park under that alternative.

Table 3-1. Assumptions Used in Analyzing Economic Impacts of LAME Regulatory Alternatives

	Alternative A	Alternative B	Alternative C	Alternative D
Annual percentage change in the number of visitors using PWC in LAME that would have occurred in the absence of a ban[a]	NA	–1.45%	–1.45%	–1.45%
Percentage of visitors that would have voluntarily reduced PWC use in LAME without the ban that would have continued to visit for other activities[b]	NA	80%	80%	80%
Net annual percentage change in visitation to LAME that would have occurred without a ban on PWC use[a,b]	NA	–0.29%	–0.29%	–0.29%
Baseline annual percentage change in non-PWC user visitation to LAME[c]	6.26%	6.26%	6.26%	6.26%
Percentage of visitors reducing PWC use in LAME due to ban that would continue to visit for other activities[b,d]	50%	50%	50%	50%
Percentage of visitors using PWC in LAME prior to ban that will continue to use PWC in LAME[b]	0%	70%	95%	100%
Percentage of visitors renting PWC for use in LAME prior to ban that will continue to rent PWC for use in LAME[b]	0%	70%	95%	100%
Percentage of visitors purchasing PWC in the LAME region prior to ban that will continue to purchase PWC in the LAME region[b]	5%	90%	95%	100%

NA = not applicable

[a]Based on annual change in PWC ownership from 1998-2001 calculated using data from the National Marine Manufacturers Association (NMMA), 2002a. This information is used to project PWC use under alternatives where continued use is authorized.

[b]NPS estimates.

[c]U.S. Bureau of Economic Analysis (BEA). 2002. U.S. Department of Commerce, Regional Accounts Data. "Bearfacts." <http://www.bea.gov/bea/regional/bearfacts/>.

[d]It was assumed that PWC users who stopped visiting the park due to a ban on PWC use rather than a voluntary retirement of their PWC would be less likely to continue visiting the park (it was assumed that 50 percent continue to visit rather than 80 percent) because many of them are likely to seek out alternative locations where they can continue to use their PWC.

It was assumed that PWC visitation and rental revenues would remain at baseline levels under Alternative A, increase to 70 percent of pre-ban levels under Alternative B, increase to 95 percent of pre-ban levels under Alternatives C, and increase to 100 percent of pre-ban levels under Alternative D.

For visitors who do not currently use PWC, visitation to the park was assumed to be increasing at an annual rate equal to the average annual population growth rate from 1990 to 2000 for the counties adjacent to LAME (see Section 2.2.3). That annual growth rate was 6.26 percent, which is extremely large relative to the national annual growth rate of 0.9 percent over that time period (Bureau of the Census, 2002). Nonetheless, NPS assumed that non-PWC user visitation would grow at this rate to be consistent with similar analyses conducted in other national parks. As noted elsewhere, this implies that estimates of benefits presented in this report represent an upper bound.

It was assumed that PWC visitation and rental revenues would remain at baseline levels under Alternative A, increase to 70 percent of pre-ban levels under Alternatives B, increase to 95 percent of pre-ban levels under Alternatives C, and increase to 100 percent of pre-ban levels under Alternative D. Note that under baseline conditions, which assume PWC are banned from LAME, PWC rentals and sales in the LAME region are assumed to fall by 100 percent and 95 percent, respectively, relative to pre-ban levels.[4]

As described in Section 2.2.3, baseline visitation for 2003-2012 was estimated by assuming that those visitors who previously used PWC in LAME but would be unable to continue using them due to a ban on their use would reduce their total visits to LAME by 50 percent (i.e., they would continue to visit the park to engage in alternative activities, but would visit less often). The scenarios outlined in Table 3-1 are used in Section 3.2 to provide estimates of potential economic impacts resulting from the restriction of PWC use in LAME. Clearly, the more current PWC users who would continue to visit LAME in the baseline, the smaller the overall impact of authorizing future PWC use will be, other things being equal. Thus, the incremental economic impacts of the regulations strongly depend on PWC users' willingness to continue visiting LAME after PWC use in the park is banned.

[4]It was assumed that there would still be a limited number of PWC sales in the region to residents who would use them elsewhere based on interviews with local businesses.

3.2 ECONOMIC IMPACT OF PWC REGULATIONS ON LOCAL ECONOMIES

The proposed regulations may affect the local economy in several ways, including changes in park visitation, sales and profits of local businesses, local employment, and local and state sales tax revenue. Generally, allowing the use of PWC in LAME to continue is expected to increase economic activity in the areas surrounding the park relative to baseline conditions. The following sections describe the estimated economic impacts on the region where the majority of the effects from reduced visitation to LAME will be felt.

3.2.1 Effect of Regulation on Visitation to LAME Area

Generally, allowing the use of PWC in LAME to continue is expected to increase economic activity in the areas surrounding the park relative to baseline conditions.

Alternatives B, C, and D are expected to lead to an increase in the number of visitor-days spent in LAME compared with the projected baseline, as shown in Table 3-2.[5] These alternatives increase visitation relative to baseline levels because they eliminate the ban on PWC use in LAME, leading to a net increase in visitation by people who currently use PWC in LAME but would have been unable to do so in the future under the baseline.[6] The increase in PWC users in the park shown in Table 3-2 reflects those visitors that used PWC in the park prior to the ban that would resume PWC use under Alternatives B, C, and D. The decrease in non-PWC visitation by former PWC users under these alternatives reflects those former PWC users that had continued to visit the park to engage in alternative activities, but will now resume PWC use instead. There is no change in visitation relative to baseline conditions expected under Alternative A because this alternative maintains baseline conditions. The incremental visitation by PWC users over time declines, while that of former PWC users increases because it is assumed that PWC use in LAME will be declining over time as described above.

[5]Visitation by PWC users is projected to be decreasing in the absence of new PWC restrictions in LAME, i.e., under pre-ban conditions (see Table 2-4). Only the change in visitation (and corresponding economic activity) relative to this baseline reduction is attributable to the alternatives for management of PWC in LAME.

[6]It is possible that there would also be a reduction in visitation by non-PWC users relative to baseline levels if PWC use were reauthorized. However, the impact of this possible reduction is expected to be small and has not been quantified due to a lack of data.

Table 3-2. Incremental LAME Visitation under Regulation Relative to Baseline Conditions[a]

	Alternative A[b]			Alternative B			Alternative C			Alternative D		
Year	Former PWC Users that Resume PWC Use[c]	Non-PWC Users[d]	Total Visitation	Former PWC Users that Resume PWC Use[c]	Non-PWC Users[d]	Total Visitation	Former PWC Users that Resume PWC Use[c]	Non-PWC Users[d]	Total Visitation	Former PWC Users that Resume PWC Use[c]	Non-PWC Users[d]	Total Visitation
2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	236,133	–118,067	118,067	320,467	–160,233	160,233	337,334	–168,667	168,667
2004	0	0	0	232,710	–116,355	116,355	315,820	–157,910	157,910	332,442	–166,221	166,221
2005	0	0	0	229,335	–114,668	114,668	311,241	–155,620	155,620	327,622	–163,811	163,811
2006	0	0	0	226,010	–113,005	113,005	306,728	–153,364	153,364	322,871	–161,436	161,436
2007	0	0	0	222,733	–111,366	111,366	302,280	–151,140	151,140	318,190	–159,095	159,095
2008	0	0	0	219,503	–109,752	109,752	297,897	–148,949	148,949	313,576	–156,788	156,788
2009	0	0	0	216,320	–108,160	108,160	293,578	–146,789	146,789	309,029	–154,515	154,515

(continued)

Table 3-2. Incremental LAME Visitation under Regulation Relative to Baseline Conditions (continued)[a]

Year	Alternative A[b]			Alternative B			Alternative C			Alternative D		
	Former PWC Users that Resume PWC Use[c]	Non-PWC Users[d]	Total Visitation	Former PWC Users that Resume PWC Use[c]	Non-PWC Users[d]	Total Visitation	Former PWC Users that Resume PWC Use[c]	Non-PWC Users[d]	Total Visitation	Former PWC Users that Resume PWC Use[c]	Non-PWC Users[d]	Total Visitation
2010	0	0	0	213,184	–106,592	106,592	289,321	–144,660	144,660	304,548	–152,274	152,274
2011	0	0	0	210,093	–105,046	105,046	285,126	–142,563	142,563	300,132	–150,066	150,066
2012	0	0	0	207,046	–103,523	103,523	280,991	–140,496	140,496	295,780	–147,890	147,890

[a]NPS generated these estimates using the assumptions in Table 3-1.

[b]NPS assumed that there would be no change in visitation relative to baseline conditions under Alternative A because this alternative maintains baseline PWC management (ban on PWC use in LAME).

[c]This column includes those visitors that use PWC in the park prior to implementation of a ban on PWC use in LAME and who would continue PWC use in the park if it were authorized under Alternatives B, C, or D. It includes both former PWC users that were assumed to visit the park for other activities during the ban (who are recategorized from non-PWC users to PWC users in this table) and former PWC users that were assumed to stop visiting the park if they are unable to use their PWC (their return to visiting the park leads to a net increase in visitation relative to baseline for Alternatives B, C, and D).

[d]These are the former PWC users that were assumed to continue to visit the park to engage in alternative activities under baseline conditions. If PWC use is authorized, these visitors are expected to resume using PWC in the park and are counted as PWC users rather than non-PWC users in the table. Without this adjustment, these visitors would be double-counted. Note that this column does not equal the values for former PWC users presented in Table 2-5 because those former PWC users that stopped using PWC voluntarily independent of the ban are assumed not to resume PWC use if it is reauthorized under Alternatives B, C, or D. Thus, there are more former PWC users in Table 2-5 than will resume PWC use, even under Alternative D. In addition, there is an increase in visitation by non-PWC users (former PWC users) over time (which shows up in the table as a smaller incremental reduction in visitation) as PWC users reduce their usage of PWC in the park based on declining national trends in PWC use.

3.2.2 Impact of Regulation on Local Business Output

As a result of the incremental increases in visitation to the LAME area expected under Alternatives B, C, and D, there will be a corresponding increase in the value of local business output. The primary sectors that are affected by increases in summer visitation are the tourism sectors, including PWC sales and rental shops, restaurants, and retailers. As discussed in Appendix A, although the direct impact of a reduction in visitor spending is primarily felt in these sectors, many additional sectors of the economy will be affected to some extent through secondary impacts. NPS focuses on the impacts estimated for 2003, the first year after implementation of the selected alternative for PWC management.

NPS used information from local businesses on the reduction in revenues that they expected under a ban on PWC use in LAME to estimate the increase in revenues that would occur under alternatives that do not include a ban.

Impacts in subsequent years will be very similar and the impact in all years is estimated to be small relative to the size of the local economy. To estimate spending impacts, it is necessary to obtain spending information for use with this study's estimates on changes in visitation. No data are available concerning the change in the number of PWC rented, sold, serviced, and stored annually that would result from LAME PWC management alternatives. Thus, NPS used information from local businesses on the reduction in revenues that they expected under a ban on PWC use in LAME to estimate the increase in revenues that would occur under Alternatives B, C, and D, which do not include a ban (i.e., assuming that PWC-related revenues would increase to pre-ban levels).

For categories of tourism spending other than direct spending on PWC, spending profiles were used in conjunction with estimated changes in visitation to determine the total change in park-related expenditures. The Money Generation Model (MGM2) is a simple input-output (I-O) model that NPS often uses to estimate local economic impacts associated with national park visitation; it provides generic spending profiles for national parks. (See Appendix A and the MGM2 website <http://www.msu.edu/user/stynes/npsmgm/> for more information about economic impact analysis using I-O models).

Based on data from Graefe and Holland (1997), NPS assumes that approximately 12.8 percent of LAME visitors are local day users, 32.2 percent are nonlocal day users, 6.9 percent stay in motels inside the park, 6.9 percent camp inside the park, 24.8 percent are

backcountry visitors, 5.5 percent stay in hotels outside the park, 5.5 percent camp outside the park, and 5.5 percent are visiting friends and relatives. Table 3-3 provides spending per party estimates used by MGM2 for these eight visitor-type groups. Only spending categories with non-zero average expenditures reported for these groups of visitors are included in the table. For this analysis, the medium[7] estimate was used for all of the spending categories analyzed. Because there is no spending category included that represents boat rentals, purchases, service, or storage, it was assumed that the spending estimates from MGM2 are in addition to the directly PWC-related expenditures described above.

The MGM2 model assumes different party sizes, average lengths of stay, and number of entries into the park for the various visitor groups based on data gathered from several national parks (e.g., visitors staying in a hotel inside a national park are assumed to have an average party size of 2.5, stay for an average of 3 days, and make two entries into the park during their stay).[8] Table 3-4 provides estimates for each alternative of the direct changes in revenues caused by a change in visitation based on the generic spending profiles for national parks from MGM2 and the information provided by local businesses. [9]

For Alternative A, the no-action alternative, PWC rental, sales, and service revenue will remain unchanged relative to the baseline because PWC will be managed according to existing regulations. Under Alternative B, PWC rental revenue is estimated to increase by approximately $3.3 million relative to the baseline estimate. PWC sales and service revenue is expected to increase by approximately $14.0 million relative to the baseline estimate. [10] Under Alternative C, NPS estimated that PWC rental revenue and PWC sales and service revenue would increase by $4.4 million and $14.9 million,

[7]MGM2 provides low, medium, and high expenditure estimates for each spending category.

[8]The model adjusts for multiple entries into the park to avoid double counting expenditures.

[9]Because MGM2 uses different assumptions for group size and multiple entries for each user category, it is not possible to use a constant party size and multiply the spending per party estimates presented in Table 3-3 by the expected changes in visitation in Table 3-2 to get the revenue impacts presented in Table 3-4.

[10]Estimated impacts on PWC rentals, sales, and service are derived from interview data collected from local firms. See Section 5 for additional information.

Table 3-3. Spending Profiles for Visitors to National Parks (2001$)[a]

	Spending per Party		
	Low	**Medium**	**High**
Local Day User			
Restaurants and bars	$8.64	$12.35	$16.05
Groceries/take-out	$4.33	$6.19	$8.04
Gas and oil	$3.37	$4.82	$6.27
Other vehicle expenses	$0.36	$0.52	$0.67
Admissions and fees	$2.94	$4.21	$5.47
Clothing	$0.69	$0.98	$1.28
Sporting goods	$0.70	$1.00	$1.29
Souvenirs and other expenses	$4.68	$6.68	$8.69
Total	**$25.72**	**$36.74**	**$47.76**
Nonlocal Day User			
Restaurants and bars	$11.52	$16.46	$21.40
Groceries/take-out	$4.33	$6.19	$8.04
Gas and oil	$6.75	$9.64	$12.53
Other vehicle expenses	$0.54	$0.78	$1.01
Local transportation	$0.18	$0.26	$0.33
Admissions and fees	$5.15	$7.36	$9.57
Clothing	$1.38	$1.96	$2.55
Sporting goods	$0.70	$1.00	$1.29
Souvenirs and other expenses	$6.48	$9.26	12.03
Total	**$37.03**	**$52.90**	**$68.77**
Motel Inside the Park			
Motel, hotel cabin or B&B	$66.89	$95.56	$124.33
Restaurants and bars	$24.49	$34.99	$45.48
Groceries/take-out	$4.33	$6.19	$8.04
Gas and oil	$6.07	$8.68	$11.28
Other vehicle expenses	$1.09	$1.55	$2.02
Local transportation	$0.36	$0.51	$0.67
Admissions and fees	$8.10	$11.57	$15.04
Clothing	$2.75	$3.93	$5.11
Sporting goods	$0.70	$1.00	$1.29
Souvenirs and other expenses	$7.92	$11.31	$14.71
Total	**$122.70**	**$175.28**	**$227.86**

(continued)

Table 3-3. Spending Profiles for Visitors to National Parks (2001$)[a] (continued)

	Spending per Party		
	Low	**Medium**	**High**
Camping Inside the Park			
Camping fees	$11.27	$16.09	$20.92
Restaurants and bars	$7.20	$10.29	$13.38
Groceries/take-out	$9.38	$13.40	$17.42
Gas and oil	$7.42	$10.61	$13.79
Other vehicle expenses	$0.54	$0.78	$1.01
Local transportation	$0.18	$0.26	$0.33
Admissions and fees	$4.42	$6.31	$8.20
Clothing	$2.06	$2.95	$3.83
Sporting goods	$0.70	$1.00	$1.29
Souvenirs and other expenses	$4.32	$6.17	$8.02
Total	**$47.49**	**$67.85**	**$88.20**
Backcountry			
Motel, hotel cabin or B&B	$3.40	$4.86	$6.32
Camping fees	$1.51	$2.16	$2.81
Restaurants and bars	$4.37	$6.25	$8.12
Groceries/take-out	$3.14	$4.48	$5.83
Gas and oil	$4.73	$6.76	$8.78
Other vehicle expenses	$0.33	$0.47	$0.61
Admissions and fees	$2.48	$3.54	$4.60
Clothing	$0.65	$0.92	$1.20
Sporting goods	$1.73	$2.47	$3.21
Souvenirs and other expenses	$4.58	$6.54	$8.50
Total	**$26.91**	**$38.45**	**$49.98**
Motel Outside the Park			
Motel, hotel cabin or B&B	$56.33	$80.47	$104.61
Restaurants and bars	$27.37	$39.10	$50.83
Groceries/take-out	$7.22	$10.31	$13.40
Gas and oil	$6.07	$8.68	$11.28
Other vehicle expenses	$1.09	$1.55	$2.02
Local transportation	$0.36	$0.51	$0.67
Admissions and fees	$8.83	$12.62	$16.41
Clothing	$4.13	$5.89	$7.66
Sporting goods	$0.70	$1.00	$1.29
Souvenirs and other expenses	$8.64	$12.34	$16.04
Total	**$122.70**	**$175.28**	**$227.86**

(continued)

Table 3-3. Spending Profiles for Visitors to National Parks (2001$)[a] (continued)

	Spending per Party		
	Low	**Medium**	**High**
Camping Outside the Park			
Camping fees	$15.49	$22.13	$28.77
Restaurants and bars	$8.64	$12.35	$16.05
Groceries/take-out	$6.49	$9.28	$12.06
Gas and oil	$7.42	$10.61	$13.79
Other vehicle expenses	$0.54	$0.78	$1.01
Local transportation	$0.18	$0.26	$0.33
Admissions and fees	$9.57	$13.67	$17.77
Clothing	$4.13	$5.89	$7.66
Sporting goods	$0.70	$1.00	$1.29
Souvenirs and other expenses	$8.64	$12.34	$16.04
Total	**$61.81**	**$88.30**	**$114.79**
Visiting Friends and Relatives			
Restaurants and bars	$8.64	$12.35	$16.05
Groceries/take-out	$8.66	$12.37	$16.08
Gas and oil	$6.07	$8.68	$11.28
Other vehicle expenses	$0.54	$0.78	$1.01
Local transportation	$0.18	$0.26	$0.33
Admissions and fees	$3.68	$5.26	$6.84
Clothing	$2.06	$2.95	$3.83
Sporting goods	$1.39	$1.99	$2.59
Souvenirs and other expenses	$7.92	$11.31	$14.71
Total	**$39.16**	**$55.94**	**$72.72**

[a]These values are based on the average expenditures per party for visitors to national parks. However, the number of people per party assumed by MGM2 may differ between visitor segments.

Source: Money Generation Model—Version 2 (Mgm2). 2002. <http://Www.msu.edu/user/stynes/npsmgm/>. As Obtained July 2002.

respectively, relative to the baseline. Alternative D is estimated to increase PWC rental revenue by about $4.7 million and PWC sales and service revenue by approximately $15.7 million relative to baseline levels.

As shown in Table 3-4, the largest direct impacts of PWC restrictions are on PWC sales and service shops, followed by PWC rental shops, restaurants and bars, souvenirs and other retail, gas and oil, motels and hotels, groceries/take-out, admissions and fees, sporting goods, camping fees, clothing, local transportation, and

Table 3-4. First Year Direct Impact of PWC Management Alternatives on Business Revenues in LAME Region Relative to Baseline (2001$)[a,b]

	Alternative A	Alternative B	Alternative C	Alternative D
PWC rentals	$0	$3,280,770	$4,452,480	$4,686,820
PWC sales/service	$0	$14,038,710	$14,864,510	$15,690,320
Motel, hotel, cabin, or B&B	$0	$775,760	$887,630	$910,000
Camping fees	$0	$190,920	$218,520	$224,040
Restaurants and bars	$0	$1,384,690	$1,584,860	$1,624,890
Groceries/take-out	$0	$652,710	$747,060	$765,930
Gas and oil	$0	$830,700	$950,780	$974,800
Other vehicle expenses	$0	$71,510	$81,840	$83,910
Local transportation	$0	$84,520	$86,760	$87,210
Admissions and fees	$0	$623,490	$713,620	$731,650
Clothing	$0	$189,380	$216,750	$222,230
Sporting goods	$0	$392,100	$415,410	$420,070
Souvenirs and other retail	$0	$855,990	$979,730	$1,004,480
Change in Total Revenue	**$0**	**$23,371,250**	**$26,199,950**	**$27,426,350**

[a]All impacts were rounded to the nearest $10. Columns may not sum to totals due to rounding.

[b]NPS generated these estimates using the MGM2 model (MGM2, 2002).

other vehicle expenses. Alternatives B, C, and D all have large positive impacts for local businesses relative to the baseline.

Note that the estimated increases in revenue in Table 3-4 overstate the true direct gains to the region because part of the sales value in the groceries/take-out, gas and oil, clothing, sporting goods, and souvenirs/retail categories goes to individuals and firms outside of the region and thus cannot be considered a gain to the LAME region. Using these changes in revenues as inputs into MGM2, NPS estimated the total regional impacts on output. As discussed in Appendix A, for the retail sector only the gain of the retail markup can be included as an increase in regional output for the local area. This explains why the direct effect on the region estimated by MGM2 (reported in Table 3-5) is smaller than the change in revenues provided as input.

Table 3-5. First Year Total Impacts on Value of Output for LAME Region (2001$)[a,b]

	Alternative A	Alternative B	Alternative C	Alternative D
Direct effect	$0	$13,657,800	$15,803,880	$16,508,540
Total impact	**$0**	**$19,301,710**	**$22,363,624**	**$23,357,480**

[a]All impacts were rounded to the nearest $10. Columns may not sum to totals due to rounding.

[b]NPS generated these estimates using the MGM2 model (MGM2, 2002).

The impacts of PWC regulation in LAME on regional output are estimated to be approximately 0.07 percent of local personal income under Alternative D, the alternative with the largest impacts.

In addition to the direct effect of the regulation on the regional economy, the indirect and induced effects (ripple effects on input suppliers and from changes in household income, respectively) are estimated (see Appendix A). The multipliers used for this analysis are those provided in MGM2 for a typical small metropolitan area. Table 3-5 summarizes the total impacts on the value of output for businesses in the LAME region. In this case, the multiplier effects are moderate. The total impact is about 40 percent larger than the direct effect. The total impact estimated for the four alternatives varies from $0 to $23.4 million depending on how many people resume visiting the park as a result of continued authorization of PWC use. The level of personal income in Clark and Mohave counties was about $44.06 billion in 2000 (BEA, 2002). Thus, the economic impact of PWC regulation in LAME on regional output is estimated to be approximately 0.07 percent of local personal income under Alternative D, the alternative with the largest impacts.[11]

3.2.3 Change in Value Added

Another measure of the impact on the local economy is the change in value added due to the regulation. Value added is the amount of dollar value contributed to a product at each stage of its production. It is calculated at each stage by subtracting the costs of intermediate goods from the value of the final good to avoid double-counting the value of intermediate goods. It will be a smaller value than output because it excludes the value of intermediate goods, whereas output measures do not exclude all intermediate goods. The output measure only excludes the cost of goods produced in other regions

[11]This is a conservative measure of the relative impact on the regional economy. For example, a portion of the estimated increase in regional output is being spent on inputs from outside the region. The estimated increase in regional personal income relative to baseline personal income is about 0.02 percent under Alternative D, the alternative with the largest impacts.

resold by wholesalers or retailers. To calculate these values for LAME, the MGM2 data for value added as a share of total output in each sector were applied to the estimated changes in local output presented in Table 3-5 to get the direct effect on value added by sector. The MGM2 multiplier for value added in each sector was then applied to estimate the total impact. Table 3-6 provides the total change in value added for the local region as a result of the proposed regulations.

Table 3-6. First-Year Total Impacts on Value Added for LAME Region (2001$) [a,b]

	Alternative A	Alternative B	Alternative C	Alternative D
Direct effect	$0	$6,769,830	$7,833,590	$8,182,870
Total impact	**$0**	**$12,724,860**	**$14,687,940**	**$15,358,060**

[a]All impacts were rounded to the nearest $10. Columns may not sum to totals due to rounding.

[b]NPS generated these estimates using the MGM2 model (MGM2, 2002).

3.2.4 Effect on Personal Income

Personal income is a portion of value added that policy makers are commonly interested in. It comprises employee compensation and proprietor income. Table 3-7 shows how labor income in the LAME region changes as a result of the proposed PWC restrictions. This value is smaller than value added because it includes only a subset of the components of value added, but it is often useful to break value added down in this way to estimate the effect on regional personal income. Similar to value added, the direct effect of this component is calculated using the MGM2 data for personal income as a share of output in each sector. The total effect is then calculated by multiplying the direct effect by the personal income multiplier included in MGM2 for each sector.

3.2.5 Change in Employment

Another effect of the proposed regulations is to increase employment in the sectors affected by the rules relative to the baseline. These changes are calculated by MGM2 based on ratios of sales to employment for the affected industries in the LAME area. As a result of the increase in sales anticipated under Alternatives B, C, and D, companies will need more employees than under the baseline. The estimated increase in employment ranges from

Table 3-7. First Year Total Impacts on Personal Income for LAME Region (2001$)[a,b]

	Alternative A	Alternative B	Alternative C	Alternative D
Direct effect	$0	$4,454,760	$5,154,740	$5,384,580
Total impact	**$0**	**$8,414,680**	**$9,809,710**	**$10,260,400**

[a]All impacts were rounded to the nearest $10. Columns may not sum to totals due to rounding.

[b]NPS generated these estimates using the MGM2 model (MGM2, 2002).

0 to 582 employees. These values are calculated based on MGM2 data on the number of employees per million dollars of output in each industry. Estimated changes in the number of employees are therefore equal to the change in output times the number of employees required per unit of output. Table 3-8 summarizes the results of the employment analysis.

Table 3-8. First Year Total Change in Employment for LAME Region (Number of Jobs)[a]

	Alternative A	Alternative B	Alternative C	Alternative D
Direct effect	0	389	453	473
Total impact	**0**	**479**	**557**	**582**

[a]NPS generated these estimates using the MGM2 model (MGM2, 2002).

3.2.6 Change in Tax Revenue

In addition to impacts on the local businesses operating near LAME, there is also an impact on the state and local governments. Because there were no data available to inform a division of the revenue and income associated with economic activity in LAME between the local counties or between Nevada and Arizona, NPS calculated the total effect on local and state governments assuming economic activity is evenly split between Clark County, Nevada and Mohave County, Arizona. The average of the state income tax rates for Nevada and Arizona is approximately 2 percent. Neither of the counties adjacent to LAME have a local income tax. The average of the two states' sales tax rates is 6.05 percent. The average sales tax rate levied by local governments is 1.5 percent for the two counties. State income taxes from affected businesses are estimated to increase by between $0 and $106,480 in the three scenarios analyzed, as presented in Table 3-9, based on estimated changes in business revenue. State sales tax receipts are predicted to increase

Table 3-9. First Year Change in State and Local Sales Tax Revenue[a,b]

	Alternative A	Alternative B	Alternative C	Alternative D
State				
Income Tax	$0	$87,820	$101,870	$106,480
Sales Tax	$0	$1,410,240	$1,583,890	$1,659,180
Local				
Income Tax	$0	$0	$0	$0
Sales Tax	$0	$349,650	$392,700	$411,370

[a]All impacts were rounded to the nearest $10. Columns may not sum to totals due to rounding.

[b]NPS generated these estimates using the MGM2 model (MGM2, 2002).

by $0 to $1.7 million. Local sales taxes are estimated to decline by $0 to $411,370.

3.2.7 Summary

NPS estimates that the total impact of the proposed alternatives for managing PWC use in LAME on regional output is $0, $19.3 million, $22.4 million and $23.4 for Alternatives A, B, C, and D, respectively, in the first year after implementation.

Several different measures of the economic impacts resulting from the restriction of PWC use in LAME were presented above. Each measure provides slightly different information about the expected economic effects on the region. Income and value added are generally considered the best measures of economic impacts because sales and job estimates can be misleading. Sales or output measures include spending on inputs purchased outside the region, and job estimates are distorted by part-time and seasonal positions because the data available are on jobs, not on full-time equivalents. In addition, the wage rates across different jobs vary widely across industries (Stynes, 2000). Income and value added measures both avoid these difficulties and concentrate on changes that affect only the LAME region.

In the analysis presented here, NPS estimates that the total impact of the proposed alternatives for managing PWC use in LAME on regional output is $0, $19.3 million, $22.4 million, and $23.4 million for Alternatives A, B, C, and D, respectively, in the first year after rule implementation (see Table 3-5). These increases are relatively small compared to the size of the regional economy, even under Alternative D, which has the largest impacts. In 2000, total personal income in Clark and Mohave Counties was about $44.06 billion in 2000 (BEA, 2002). Thus, even under the alternative with the largest impacts, Alternative D, the impact would be small

(regional output increases by about 0.07 percent of personal income), although some businesses and communities in the county that rely heavily on PWC users may experience relatively large localized impacts.

3.2.8 Uncertainty

A number of factors will affect the regional economic impacts associated with the proposed alternatives. One recent regulation enacted by EPA in 1996 that may have an impact on PWC use nationally and in LAME is the 1996 EPA rule for New Gasoline Spark-Ignition Marine Engines (hereafter referred to as the 1996 EPA Marine Engine Rule). This rule requires PWC (and other spark-ignition [SI] marine engine) manufacturers to reduce emissions by 75 percent from the 1998 model year until the 2006 model year (*Federal Register*, 1996). In their analysis of the rule, EPA predicted that the emissions from all of the regulated engines in use will decrease by approximately 75 percent from baseline emission levels by the year 2025. The delay in actual emission reductions for machines in use is due to the long lives of some marine engines. EPA predicts that complete fleet turnover for some engines may not occur until 2050. However, EPA assumes that the life cycle for PWC is 10 years, considerably shorter than their assumptions for the life cycles of some of the other SI marine engines covered by the rule (*Federal Register*, 1996). According to the Personal Watercraft Industry Association (PWIA), PWC manufacturers have already reduced the emissions of PWC significantly, and many of the newer PWC models already comply with the 1996 EPA Marine Engine Rule (PWIA, 2002).

NPS identified the following additional uncertainties in the projections of baseline visitation:

Although NPS has provided their best estimate of the regional economic impacts associated with the proposed alternatives, numerous sources of uncertainty may influence the results.

- The projections of PWC use through 2012 in the absence of a ban were based on NPS estimates of PWC use in 2001 (see Section 2.2.4 for uncertainties related to this estimate). To the extent that PWC users accounted for an unusually small or large proportion of total visitation in 2001, projected visitation may be understated or overstated.
- The proportion of PWC users who will continue to visit the park following implementation of new regulations is unknown. The actual proportion of users who continue to visit may be higher or lower than assumed in this analysis.
- The trends in local population growth may not constitute a good proxy for the future annual change in visitation to

LAME by non-PWC users. It may understate or overstate the actual change in LAME non-PWC visitation that would occur in future years under baseline conditions. The uncertainties associated with the baseline projections are discussed in further detail in Section 2.2.4.

- The rule proposal process itself may have affected the number of PWC users who visited LAME in 2001. If there was a reduction in PWC use in GUIS due to uncertainty over future restrictions in PWC use, then the results of this analysis will not reflect this reduction. However, it is not clear that the prospect of future restrictions would have caused a reduction in visitation. In fact, it may have lead to just the opposite effect as people attempted to access GUIS prior to additional restrictions being implemented.
- The change in PWC visitation that would occur in the absence of the ban is estimated using data on national PWC ownership, which is only an approximation for the trend in LAME PWC use.
- The scenarios used to predict impacts on local businesses were developed by NPS based on conversations with a number of local businesses. To the extent that the expected impacts on these businesses are not representative of all affected businesses in the GUIS region, the estimated impacts may be influenced upwards or downwards.
- EPA regulations phasing in emissions reductions from new PWC over the period from 1996 to 2006 are expected to increase the cost of producing PWC over time. The corresponding increase in market price of PWC may lead to a reduction in sales that would reduce baseline PWC ownership and use relative to the projected levels. This would tend to reduce the incremental costs attributable to NPS regulations in future years. However, cost increases due to these regulations are probably captured in the current baseline to some degree because the rule has already required some reduction in emissions.
- Generic spending patterns and multipliers from MGM2 were used to represent economic activity in the LAME area. To the extent that spending patterns of PWC users in LAME differ from the generic spending of local and nonlocal day users and/or the generic multipliers for a national park in a small metropolitan area differ from the multipliers for the LAME region, the impacts may be understated or overstated.
- In addition, general uncertainties and caveats are associated with the use of I-O models. These factors are described in further detail in Appendix A.

4 Benefit-Cost Analysis of the Alternative Regulations

The purpose of benefit-cost analysis is to evaluate the social welfare implications of an action—in this case the regulation of PWC use in national parks. The impacts of this action, both the benefits and costs, will ultimately be experienced as changes in well-being for households/individuals.

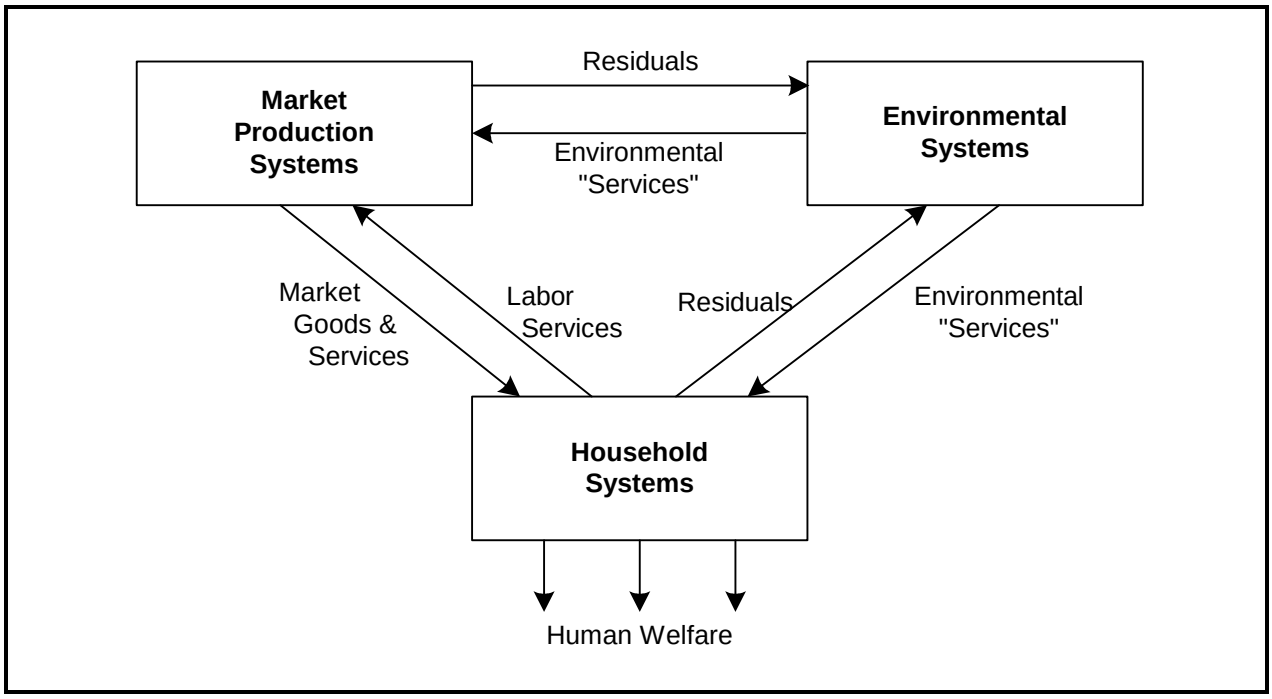
The purpose of benefit-cost analysis is to evaluate the social welfare implications of an action—in this case the regulation of PWC use in national parks. It examines whether the reallocation of society's resources resulting from the action promotes efficiency. That is, it assesses whether the action results in benefits (gains in social welfare) greater than the associated costs to society (losses in social welfare).

Section 4.1 provides a general outline of the approach to benefit-cost analysis and the possible benefits and costs of PWC regulations in national parks. Section 4.2 presents the analysis for LAME specifically.

4.1 CONCEPTUAL BASIS FOR BENEFIT-COST ANALYSIS OF PWC RESTRICTIONS IN NATIONAL PARKS

According to the conceptual underpinnings of benefit-cost analysis, all social welfare impacts ultimately accrue to individuals. This is represented in Figure 4-1, which depicts flows of goods, services, and residuals among three major systems: market production, household, and the environment. Because these systems are closely interconnected, actions taken to reduce releases of harmful residuals (e.g., chemicals or noise pollution) to the environment will potentially reverberate throughout all of these systems.

Figure 4-1. Interrelationship Among Market, Environmental, and Household Systems and Social Welfare



Nevertheless, the impacts of regulatory actions, both the benefits and costs, will ultimately be experienced as changes in well-being for households/individuals. As a result, identifying and measuring benefits and costs must focus on these changes in well-being.

The conceptual framework depicted in Figure 4-1 therefore provides a basis for assessing the benefits and costs of PWC regulations in national parks. In these cases, the most direct impact will be on households that use PWC, whose recreational opportunities will be affected by the regulations. This will result in direct changes in welfare for these households. In addition, the resulting changes in the behavior of these households are likely to affect environmental systems and market systems. Effects on these systems will indirectly affect the welfare of other households. For example, the park environment will be improved or degraded, and this change will change the "services" (primarily recreation-related) that the park provides to other households and individuals in society. Businesses that cater to non-PWC visitors may also be affected if the number of people visiting the park changes. On the other hand, the resulting change in the market demand for PWC-related goods and services

will have impacts for those who own or work for establishments supplying these services.

These types of direct and indirect impacts are identified and evaluated as part of this benefit-cost analysis. Specifically, in Section 4.2 NPS estimates the incremental benefits and costs relative to the baseline.

In certain instances, welfare changes are directly the result of monetary gains or losses and can therefore be thought of as being equivalent to these gains or losses. In other instances, welfare changes are not directly associated with pecuniary gains or losses.

Estimating the value of benefits and costs also requires methods for expressing welfare changes in monetary terms. In certain instances, welfare changes are directly the result of monetary gains or losses and can therefore be thought of as being equivalent to these gains or losses. For example, welfare gains or losses to PWC sales shops due to changes in demand for their services can be reasonably measured as their resulting net change in income. In other instances, welfare changes are not directly associated with pecuniary gains or losses. Such "nonmarket" changes might, for example, include the welfare gains or losses from improved or degraded recreational opportunities in a park. In these cases a surrogate measure of gains or losses must be used; willingness to pay (WTP) is such a surrogate. Economists and other practitioners of benefit-cost analysis generally accept WTP as the conceptually correct measure for valuing changes in individuals' welfare. WTP represents the maximum amount of money that an individual would be willing to forgo to acquire a specified change. As such, it is the monetary equivalent of the welfare gain from the change.

Using this conceptual framework for identifying, measuring, and valuing changes in societal welfare, the remainder of this section and Appendix A provide a more detailed discussion of

- ➤ the types of benefits and costs associated with PWC regulations in national parks and
- ➤ the approaches used in measuring these benefits and costs.

4.1.1 Social Costs of PWC Use

Use of PWC in national parks may be associated with a number of negative impacts on environmental resources and ecosystems. The extent to which adverse impacts will be realized is a function of several factors, including the level of use, the technology of the machines being used, and the extent to which users remain in designated areas. One result of any negative impacts that occur is that they impose welfare losses on individuals who value the parks'

environmental systems. The negative impacts of PWC use on other people are also referred to as negative externalities. If PWC generate negative externalities, then this represents a market failure. The private cost of using a PWC (the cost to the individual PWC user) will be lower than the social cost of PWC use (where the social cost of PWC use includes both the cost to the PWC user plus the costs to others that result from the negative externalities associated with PWC use). Because PWC users do not have to pay the full social cost of using a PWC and instead only pay the lower, private cost, PWC use will be maintained at a higher level than socially optimal in the absence of regulation.

The private cost of using a PWC is lower than the social cost of PWC use. Because PWC users do not have to pay the full social cost of using a PWC and instead only pay the lower, private cost, PWC use will be maintained at a higher level than socially optimal in the absence of regulation.

The costs of allowing PWC in national parks can therefore be thought of and measured as the increase in these incremental losses to society. In addition, use of PWC can negatively affect society in ways that are not directly related to the environment; therefore, the incremental costs of PWC regulations must also include increases in these nonenvironmental losses.

Table 4-1 provides a broad classification of the types of environmental and nonenvironmental impacts associated with PWC use in national parks. In this section, this classification is used to more completely identify, categorize, and describe the full range of potential costs associated with PWC regulations in national parks in general. In Section 4.2.3, this framework is then used to specifically describe the costs that are expected to result from the management alternatives for LAME.

Table 4-1. Classification of Potential Negative Impacts from PWC Use in National Parks

Impact Categories	Examples of Impacts
Environmental impacts	
Aesthetic	Noise, visibility, odor
Human health	Through impacts to air and water quality
Ecosystems	Loss of or damage to habitat and wildlife
Nonenvironmental impacts	
Infrastructure	Costs of monitoring, maintenance, and law enforcement
Human safety	Accidents
Cultural, historical, and archeological	Physical damages

The value that people place on a particular recreational activity depends strongly on the availability of substitutes. In areas where there are numerous areas available for recreational activities, the value of changing environmental conditions in one of those areas will tend to be smaller.

Environmental Costs of PWC Use

The use of PWC may have adverse impacts on air quality; natural resources (e.g., water quality, habitat); wildlife; and natural quiet. Figure 4-2 depicts the various categories of potential adverse effects to the environment through which PWC use in national parks can impose welfare losses on society.

- ➤ Typical PWC release substantial amounts of noise and pollutants into the environment. Noise from PWC impairs the natural soundscape for park visitors and has the potential to negatively affect wildlife in the park. Emissions from PWC can also negatively affect park ecosystems, human health, and visitor experiences. The three primary reasons for the potential impacts due to release of pollutants are:
  - ✓ up to one-third of the fuel delivered to the engine is expelled without being burned,
  - ✓ lubricating oil is mixed with fuel and thus is expelled as part of the exhaust, and
  - ✓ the combustion process results in high emissions of air and water pollutants.

Pollutants are directly released to air and water, causing contamination of air and water resources.

As shown in Figure 4-2, all of these impacts can, directly or indirectly, lead to losses in human welfare. Therefore, from a benefit-cost perspective, those who ultimately lose from actions to allow PWC will be individuals who value the quality of the park environment. Many of those that experience losses will be park visitors whose recreational experiences are disturbed. As a point of reference, Table 4-2 reports average consumer surplus values that have been estimated for common non-PWC-related summer recreation activities from a study by Rosenberger and Loomis (2000). These are the types of recreation values that may be diminished by the presence of PWC.

The value that people place on a particular recreational activity depends strongly on the availability of substitutes. In regions where there are numerous areas available for recreational activities, the value of changing environmental conditions in one of those areas will tend to be smaller. The reason is that there are already many other areas where people can engage in the same activity. Unless there are unique characteristics that people value in the area where

Figure 4-2. Routes of Environmental Damages and Human Welfare Losses from PWC Use in National Parks

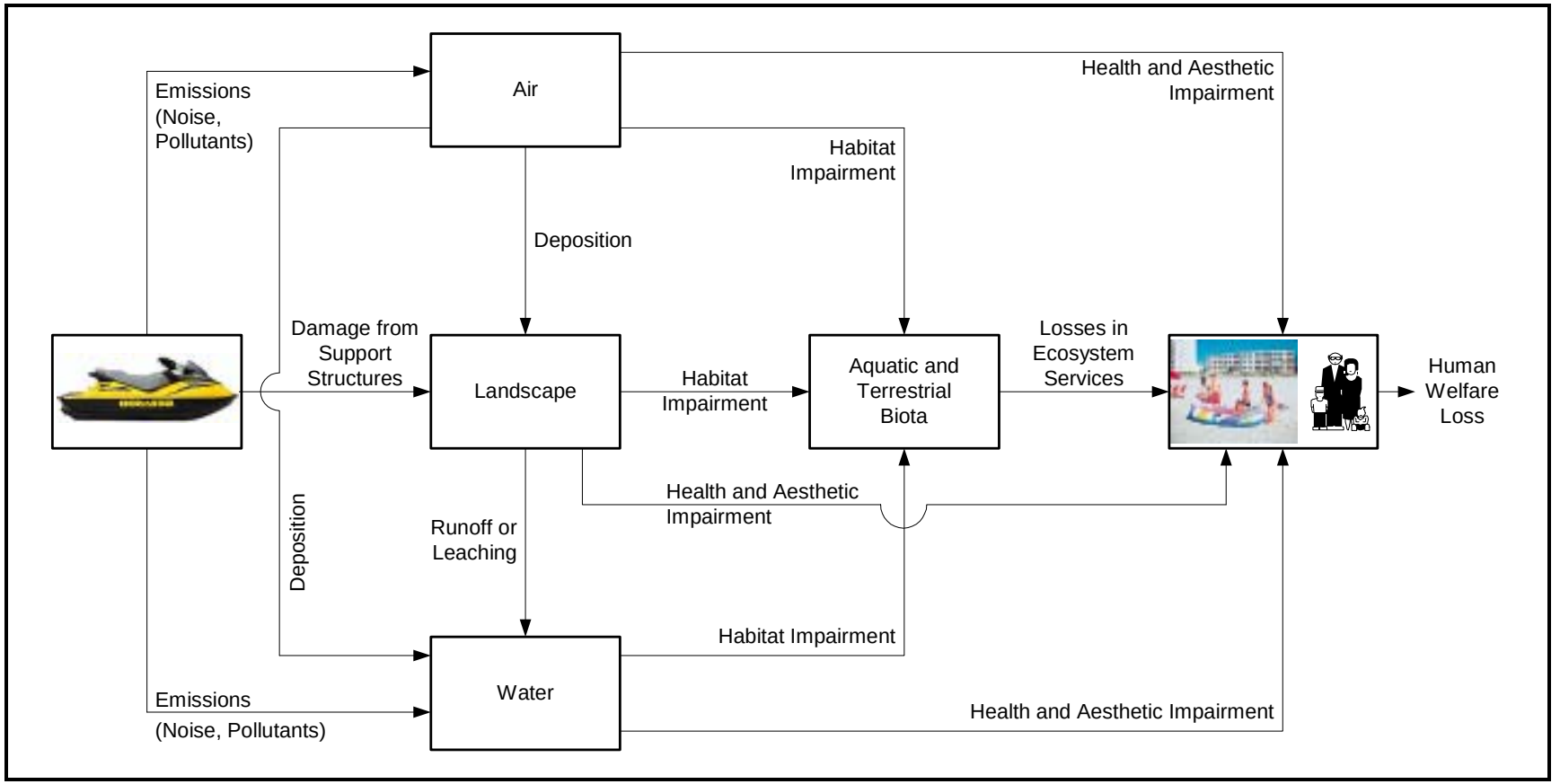


Table 4-2. Summary of Average Recreation Values (2001$ per Person per Day) for Selected Activities by Region[a,b]

Activity	Study Location					U.S. Average
	Northeast	Southeast	Mountain	Pacific	National[c]	
Picnicking	$59.46 (1)	$40.10 (1)	$39.10 (7)	$79.62 (2)	$16.89 (1)	$45.78 (12)
Swimming	$40.06 (5)	NA	NA	$16.10 (1)	$22.26 (1)	$34.10 (7)
Hiking/backpacking	$48.46 (2)	$118.40 (2)	$40.29 (3)	$21.95 (6)	$22.47 (1)	$43.48 (14)
Fishing	$34.06 (42)	$29.87 (13)	$45.75 (39)	$39.96 (16)	$40.12 (4)	$38.62 (114)
Motor boating	$56.46 (2)	NA	$74.04 (2)	$16.29 (1)	$41.67 (1)	$53.16 (6)

NA = Not available.

[a]All amounts were inflated using the consumer price index for recreation available from the U.S. Bureau of Labor Statistics (2002). Numbers in parentheses represent the number of observations (i.e., studies).

[b]These values were taken from multiple studies conducted between 1967 and 1998.

[c]Studies estimating nationwide values.

Source: Rosenberger and Loomis, 2000.

conditions will be improved or degraded, there will probably be relatively small benefits or costs as a result of the environmental change. On the other hand, in regions with few substitutes for the local national park that would potentially experience environmental damage as a result of the regulations, the losses to park users may be much greater.

Even individuals who are not park visitors (i.e., nonusers) can benefit from the knowledge that park resources are being protected and preserved. In other words, they may hold positive or negative "nonuse values" (i.e., a positive WTP) for protecting or degrading the park environment. These nonuse values can stem from the desire to ensure others' enjoyment (both current and future generations) or from a sense that these resources have some intrinsic value. Pearce and Moran [1994] review studies that have attempted to estimate nonuse values for the protection of unique species and ecosystems. The measurement of nonuse value remains controversial, and in this report NPS does not attempt to quantify the possible benefits or costs associated with nonuse values. Allowing PWC use in national parks can therefore result in losses to both users and nonusers in a number of ways by degrading the parks' ecological resources.

Appendix B provides a more detailed discussion of the nonenvironmental impacts, in particular, how these restrictions can affect public safety in national parks and the costs of operating and maintaining the infrastructure necessary to support and monitor PWC use.

4.1.2 Social Benefits of PWC Use

The primary benefits associated with allowing the use of PWC in national parks will accrue to

- PWC users, especially individuals who would otherwise not use PWC in a particular park as a direct result of restrictions on PWC use, and
- providers of PWC-related services for park visitors.

After conducting an extensive review of the economics literature and consulting with the authors of existing studies, experts in recreation demand analysis at universities, and other experts, NPS was unable to locate a study that estimated the consumer surplus for a PWC trip.

Just as Section 4.1.1 described potential consumer surplus losses to other park visitors and the public associated with PWC use, the potential welfare gains to PWC users are measured in terms of consumer surplus. Regulations that restrict the use of PWC impose costs on PWC users. For instance, prohibiting PWC use in the park has resulted in a loss of consumer surplus for former LAME PWC users. Allowing PWC use in LAME under restrictions such as limiting the areas of the park that are open to PWC, imposing no-wake zones, or requiring newer technology would increase the consumer surplus of PWC users relative to baseline. A return to pre-ban PWC management practices would increase the consumer surplus of PWC users even further.

As with other activities, the extent of the welfare gain to an individual rider depends crucially on the availability of substitute areas to use PWC and/or to engage in other recreational activities. All else equal, individuals who have fewer substitutes for PWC use (either other places to use PWC or other activities they enjoy as much) enjoy greater consumer surplus from PWC use in a particular body of water and thus will experience a greater gain in welfare if that body of water is opened to PWC use.

After conducting an extensive review of the economics literature and consulting with the authors of existing studies, experts in recreation demand analysis at universities, and other experts, NPS was unable to locate a study that estimated the consumer surplus for a PWC trip. Table 4-2 presents the results of a review of the recreation literature conducted by Rosenberger and Loomis (2000).

The review found an average value of $49.37 (1996 dollars) per person per day for riding in motor boats (with estimates ranging from $15 to over $65). The same study reports a value of $26.79 (1996 dollars) per person per day (with estimates ranging from $20 to over $30) for off-road driving. Bhat et al. (1998) report consumer surplus estimates ranging from $9.12 to $54.93 for motorboating and waterskiing in different regions of the country. These estimates, along with the estimates in Table 4-2, provide a range of values for activities similar to riding PWC and provide a bound on the consumer surplus gain for PWC users expected from the regulations. Note that measures of net consumer surplus to PWC riders that do not account for the additional costs imposed on society by the negative externalities associated with PWC use will overstate the true net social welfare associated with the activity.

Even PWC users who do not currently visit the park may have a positive value associated with maintaining access for PWC in parks that they could potentially decide to visit in the future. These users hold an option to visit the park in the future. Restrictions on PWC access to parks would reduce or eliminate the value of that option. Thus, PWC users that do not visit the park may still experience a gain in welfare if the park allows PWC use. However, due to a lack of information concerning the population of PWC users who may potentially choose to visit a given park in the future and the value that they place on that option, NPS does do not attempt to quantify the potential gains in option value.

An increase in PWC use at a particular park may also impact businesses that offer services to PWC users. These businesses are not directly affected by NPS regulations of PWC users (i.e., none of the regulations directly require any action from PWC dealerships, rental shops, or other businesses), but are likely to be impacted nonetheless. For example, allowing PWC use in national parks may lead to increased demand for PWC sales or rentals and decreased demand for motorboats or canoes. These shifts in demand may reallocate sales among businesses and may lead to an increase in total revenue for businesses providing tourism-related services. As described in Section 3, there may also be ripple effects on the local economy. If businesses that serve PWC users experience an increase in demand for their services, they will most likely increase their purchases of inputs from other sectors of the local economy,

including labor. In addition, an increase in revenue for local firms tends to increase regional income. Increases in average household income for the region surrounding the park will also lead to increases in sales for local businesses as local households respond by purchasing more goods (see Appendix A for more detailed information on ripple effects).

Whether these indirect, or secondary, impacts should be included as a change in social welfare in the benefit-cost analysis depends on whether the change in demand or supply in the secondary market results in price changes (for details, see a benefit-cost analysis textbook such as Boardman et al. [1996]). In general, when the policy change in the primary market (PWC trips to a national park) causes prices to change in the secondary markets, the net change in social welfare from the secondary market should be included in the benefit-cost analysis. If prices do not change in the secondary market, the revenue gains or losses should not be included in the benefit-cost analysis. If the people who would have used PWC in the national park spend their money elsewhere instead, this represents a transfer from one region of the country to another or from one business to another. While the loss in revenue may hurt the businesses located near the national park, from society's point of view this represents a transfer of income rather than a true cost to society as a whole.

Without more detailed information, it is difficult to predict with certainty whether the alternatives will change prices for PWC sales or rentals. However, NPS feels it is quite possible that the changes in demand that would occur under these alternatives may result in price changes for PWC-related markets. Thus, losses or gains to tourism-related businesses that may be indirectly affected by the rule are included in the benefit-cost analysis.

4.2 RESULTS FOR LAKE MEAD NATIONAL RECREATION AREA

Based upon the approach and possible impacts outlined above, this section presents the results of the benefit-cost analysis for LAME. The section discusses the groups most directly affected by the alternatives for management of PWC use in the park and several scenarios for the possible levels of impacts. The benefits and costs

accruing to these groups, relative to the baseline (where PWC are banned from LAME), are then presented.

4.2.1 Affected Groups

For the purpose of this study, six major affected groups, listed in Table 4-3, have been identified:

1. PWC users, in particular those who currently use PWC in LAME and those who may wish to use PWC in LAME in the future.
2. Other visitors or potential visitors who may have a different experience at the park if PWC are banned or restricted in LAME (canoeists, anglers, swimmers, hikers, boaters, and other visitors).
3. Producers of PWC services in the area surrounding LAME who may experience a change in their welfare when PWC use in the park changes (e.g., PWC rental shops, PWC sales shops, restaurants, gas stations, hotels).
4. Local residents of the area surrounding LAME.
5. Producers of services to other types of summer visitors (e.g., canoe rentals or powerboat rentals) who may experience a change in their welfare related to the number of PWC users in the park.
6. The general public who may care about the natural resources in LAME even if they do not visit the park.

Alternatives B, C, and D negatively affect all park visitors except PWC users, PWC dealerships, and other businesses that provide services to PWC users because PWC use in LAME is authorized. PWC users will gain consumer surplus under all of these alternatives.

The impacts on these groups under each alternative are discussed in more detail below.

Alternative A, which bans PWC from LAME in April 2003, will have no effect on any of the user groups relative to baseline conditions because it maintains baseline PWC management.

Alternative B negatively affects all users except PWC users, PWC dealerships, and other businesses that provide services to PWC users, because PWC would be allowed in all but approximately 10 percent of the waters of LAME. Local shops with PWC-related revenue will experience gains in producer surplus to the extent that these changes cause PWC users to return to LAME. However, allowing PWC in the park would generally be expected to have negative impacts on other boaters' consumer surplus. Although congestion and the risk of accidents in NPS waters increases, it is possible that congestion in the waters outside of LAME, such as the area of the Colorado River south of Davis Dam, will decrease

Table 4-3. Impact of Alternatives on User Groups

User Group	Alternative A (No-Action)	Alternative B	Alternative C	Alternative D
1. PWC Users or Potential PWC Users	• No change in consumer surplus.	• Consumer surplus is expected to increase substantially as a result of lifting the ban on PWC use in LAME, though not as much as in Alternatives C and D because of spatial restrictions on PWC use and engine-type restrictions.	• Consumer surplus is expected to increase substantially as a result of lifting the ban on PWC use in LAME, although less than under Alternative D due to more stringent spatial restrictions and implementation of engine restrictions.	• Consumer surplus is expected to increase substantially as a result of lifting the ban on PWC in LAME.
2. Other Visitors or Potential Visitors: Canoe Users, Anglers, Other Boaters, Swimmers, Hikers and Other Visitors	• No change in consumer surplus.	• Consumer surplus is expected to decrease slightly for current users of LAME as a result of decreased solitude, decreased water quality, and an increase in the risk of accidents involving PWC. • Consumer surplus is expected to decrease for potential visitors who would have visited LAME with a ban on PWC use.	• Consumer surplus is expected to decrease slightly more than under Alternative B for current users of LAME as a result of decreased solitude, decreased water quality, and an increase in the risk of accidents involving PWC. • Consumer surplus is expected to decrease by a slightly larger amount than under Alternative B for potential visitors who would have visited LAME with a ban on PWC use.	• Consumer surplus for current users of LAME is expected to decrease as a result of decreased solitude, decreased water quality, and an increase in the risk of accidents involving PWC. • Consumer surplus is expected to decrease by a greater amount than for Alternatives B and C for potential visitors who would have visited LAME with a ban on PWC use.

(continued)

Table 4-3. Impact of Alternatives on User Groups (continued)

User Group	Alternative A (No-Action)	Alternative B	Alternative C	Alternative D
3. Producers of PWC services: PWC rental shops PWC sales shops Other parts of the local economy providing services to PWC users	• No change in producer surplus.	• PWC rental shops are expected to experience a large increase in producer surplus. • PWC sales shops are expected to experience a large increase in producer surplus. • Other parts of the local economy such as hotels, restaurants, and gas stations located near LAME may have an increase in producer surplus. However, it is not expected that there will be measurable impacts on the regional economy.	• PWC rental shops are expected to experience a larger increase in producer surplus than under Alternative B. • PWC sales shops are expected to experience a larger increase in producer surplus than under Alternative B. • Other parts of the local economy such as hotels, restaurants, and gas stations located near LAME may have an increase in producer surplus. However, it is not expected that there will be measurable impacts on the regional economy.	• PWC rental shops are expected to experience an increase in producer surplus larger than under Alternatives B and C. • PWC sales shops are expected to experience an increase in producer surplus larger than under Alternatives B and C. • Other parts of the local economy such as hotels, restaurants, and gas stations located near LAME may have an increase in producer surplus. However, it is not expected that there will be measurable impacts on the regional economy.
4. Local Residents of the area surrounding LAME	• No change in welfare.	• Local residents who use PWC may experience an increase in welfare due to a reduction in the restrictions on the use of PWC in LAME. • Local residents who do not use PWC may experience a decline in welfare as a result of an increase in noise, decreased water quality, and an increase in the risk of accidents involving PWC.	• Local residents who use PWC may experience an increase in welfare due to a reduction in the restrictions on the use of PWC in LAME. • Local residents who do not use PWC may experience a decline in welfare as a result of an increase in noise, decreased water quality, and an increase in the risk of accidents involving PWC.	• Local residents who use PWC may experience an increase in welfare due to a reduction in the restrictions on the use of PWC in LAME. • Local residents who do not use PWC may experience a decline in welfare as a result of an increase in noise, decreased water quality, and an increase in the risk of accidents involving PWC.

(continued)

Table 4-3. Impact of Alternatives on User Groups (continued)

User Group	Alternative A (No-Action)	Alternative B	Alternative C	Alternative D
5. Producers of services for visitors to LAME who do not use PWC	• No change in producer surplus.	• Producer surplus may decrease because lifting restrictions on PWC may result in a decrease in demand for other activities in LAME, resulting in a decreased demand for the provision of services related to these activities.	• Producer surplus may decrease because lifting restrictions on PWC may result in a decrease in demand for other activities in LAME, resulting in a decreased demand for the provision of services related to these activities. The decrease in producer surplus under this alternative is expected to be larger than under Alternative B.	• Producer surplus may decrease because lifting restrictions on PWC may result in a decrease in demand for other activities in LAME, resulting in an decreased demand for the provision of services related to these activities. The decrease in producer surplus is expected to be larger than under Alternatives B and C.
6. The general public who may care about the natural resources in LAME even if they do not visit	• No change in welfare.	• May experience a decrease in welfare as a result of degraded nonuse values resulting from decreased environmental quality.	• May experience a decrease in welfare as a result of degraded nonuse values resulting from decreased environmental quality. The decrease in welfare is expected to be larger than under Alternative B due to fewer restrictions and limitations on PWC use in LAME.	• May experience a decrease in welfare as a result of degraded nonuse values resulting from decreased environmental quality. The decrease in welfare is expected to be larger than under Alternatives B and C due to less restrictions placed on PWC use in LAME.

relative to baseline levels. Also, the requirement to implement the ban on noncompliant machines within a year would cause welfare gains to PWC users to be smaller than under Alternatives C and D because PWC users are forced to buy new PWC sooner than they otherwise would have if they want to use PWC in LAME. Because people tend to replace PWC every five to seven years, a phase-in period shorter than seven years is likely to affect the purchase decisions of many PWC users (i.e., those that have PWC less than seven years old).[1] In addition, compliant PWC are currently more expensive than noncompliant PWC.

Alternative C negatively affects all users except PWC users, PWC dealerships, and other businesses that provide services to PWC users, because PWC use would be allowed in all but approximately 5 percent of LAME waters. Local shops with PWC-related revenue will experience gains in producer surplus to the extent that these changes cause PWC users to return to LAME. However, other sectors will generally experience a reduction in welfare. The slower transition to compliant PWC will result in greater consumer and producer surplus gains to PWC users and businesses that provide PWC-related services, respectively, than under Alternative B. As outlined above, the impact on boaters inside LAME is most likely negative, but it is possible that there would be slightly less congestion outside of park waters. The adverse effects to swimmers, as well as canoeists and potentially other boaters, are increased under Alternative C relative to Alternative B.

Under Alternative D, NPS expects large negative welfare effects for all users except PWC users, PWC dealerships, and other businesses that provide services to PWC users. Adverse impacts of PWC on swimmers, canoeists, and other users within LAME relative to the baseline are greatly increased under this alternative because PWC are allowed within the park's boundaries as previously managed. The impact on boaters is somewhat ambiguous as described above. In addition, many houseboat users enjoy using PWC as part of their boating trips and may experience welfare gains as a result of lifting the PWC ban.

[1] PWC dealerships in the LAME area interviewed by NPS indicated a shorter replacement period for PWC, typically about three years. However, NPS believes that the five to seven year estimate of the typical replacement period is more reliable than the three-year estimate because it is based on a larger sample of PWC users.

4.2.2 Scenarios

NPS considers a ban on PWC use in LAME to be the baseline with which the alternatives are compared.

To develop estimates of the benefits and costs of the rule under each alternative, NPS used the scenarios described below. NPS considers the no-action alternative to be the baseline to which the alternatives are compared. It should be noted that under the baseline projections, park-related PWC rentals are assumed to have declined by 100 percent relative to pre-ban levels[2] and park-related PWC sales and service revenues are assumed to have declined by 95 percent relative to pre-ban levels.

Alternative A (No Action)

This alternative would result in a ban of PWC from LAME. Under this alternative NPS assumes there will be no impacts on revenues for businesses providing services to PWC users relative to the baseline because it maintains baseline PWC management.

Alternative B

The second alternative allows PWC use in LAME, but places geographic restrictions on PWC. In addition, this alternative bans all EPA noncompliant two-stroke engines within a year of implementation. For this alternative, NPS assumes that park-related revenues for PWC sales and service shops will increase to 90 percent of pre-ban levels based on interviews with local businesses. Many PWC rental shops will have to replace their fleet to obtain machines compliant with engine-type restrictions. NPS assumes that the LAME PWC rental industry will see an increase in revenue to 70 percent of previous levels.

Alternative C

The third alternative also allows continued PWC use in LAME but restricts less of the lake than Alternative B, defining approximately 5 percent of the lake area in the park as primitive or semiprimitive areas where PWC are generally not allowed. In addition, conventional two-stroke engines will be banned in 2012. Under this alternative, NPS assumes that PWC sales, service, and rentals related to the park will increase to 95 percent of pre-ban levels based on interviews with local businesses.

[2] Levels of revenue that would have occurred if PWC were allowed as previously managed prior to 2003.

Alternative D

Alternative D allows PWC use in LAME according to the rules and regulations that were in effect prior to 2003. For Alternative D, it is expected that PWC users who previously used PWC in the park would return under management strategies that allowed them to continue using their PWC in the park.

4.2.3 Costs

As described in Section 4.1 and Appendix B, PWC use in national parks can be linked to a wide variety of negative impacts. Allowing their use in these parks can therefore result in a number of different costs to society. Section 2.5 specifically describes the impacts on natural resources that are most likely to result from PWC use within the boundaries of LAME. This section describes how these impacts will be affected by the alternatives identified above for PWC management in LAME and assesses the costs of these regulations. Assessing the costs in strictly quantitative (i.e., monetary) terms is not feasible with currently available data; therefore, the costs are described in qualitative terms.

The group of visitors that would bear the largest share of the costs associated with Alternatives B, C, and D would be LAME visitors who do not use PWC and whose park experience is negatively affected by the presence of PWC.

The group of visitors that would bear the largest share of the costs associated with Alternatives B, C, and D would be LAME visitors who do not use PWC and whose park experience is negatively affected by the presence of PWC. Annual visitation to LAME is approximately 8 to 10 million people per year, most of whom come to the park for some form of water-based recreation. Graefe (1997) estimates that PWC users account for 35 percent of the water-based recreationists on the lakes during the summer months and 14 percent during the winter months. As discussed in Section 2.2, NPS estimates that the number of visitors using PWC in LAME ranges between 240,000 and 435,000 people annually, or about 3 to 5 percent of annual LAME visitation. Other popular activities in LAME include boating, canoeing, fishing, and hiking.

"Nonusers" of the park are also likely to experience welfare losses if PWC are allowed in LAME (see Section 4.1 and Appendix B for more details). For example, individuals who do not visit the parks can experience a decline in welfare simply from the knowledge that the natural resources of the park may be degraded by PWC use. Part of this loss may stem from a decreased assurance that the quality of the parks' resources is being protected for the enjoyment

of future generations. Therefore, some of the cost categories described below, in particular those associated with the degradation of unique park resources and ecosystems, may accrue in the form of nonuse values.[3]

Aesthetic Costs—Noise and Visibility Impairments

Alternatives that allow PWC use will increase noise levels in LAME and reduce the level of natural quiet along portions of the shoreline. They also have the potential to degrade visibility by leading to an increase in the amount of ozone-causing emissions. However, because a large number of motorized boats already operate along the shore in the baseline, the incremental negative impacts of allowing PWC in the park are likely to be very small.

Alternative A (No-Action Alternative): This alternative continues baseline management and offers no change in soundscape or visibility relative to baseline conditions.

Alternative B: This alternative will allow PWC to return to approximately 90 percent of the waters of LAME. However, conventional two-stroke engines will be prohibited from LAME within a year of implementation, which will result in the replacement of conventional two-stroke PWC with quieter, more environmentally friendly machines. Areas where PWC use is authorized may experience minor detrimental impacts in soundscape quality, but noise from other boating activities would have infiltrated most park areas in the baseline even without PWC. This minimizes the incremental impact associated with PWC use. Areas with relatively low motorized use in the baseline will see the greatest impairments from this alternative. Visibility impacts would be negligible.

Alternative C: Under this alternative, PWC use is authorized in approximately 95 percent of the waters of LAME. Areas where PWC use is authorized may experience minor detrimental impacts in

[3]The importance of recognizing these values is affirmed in the Organic Act. It established the fundamental purpose of the national park system, which includes providing for the enjoyment of park resources and values by the people of the United States. The mandate applies not just to the people who visit parks—but to all people—including those who derive inspiration and knowledge from afar. Furthermore, through the Redwood Act of March 27, 1978, Congress has provided that when there is a conflict between conserving national park resources and values and providing for enjoyment of them, conservation is to be the primary concern.

soundscape quality, but noise from other boating activities would have infiltrated most park areas in the baseline even without PWC. This minimizes the incremental impact associated with PWC use. Areas with relatively low motorized use in the baseline will see the greatest impairments from this alternative. Visibility impacts would be negligible.

Alternative D: This alternative will have the greatest impact because it will allow PWC in all areas of LAME. However, as described above, noise from other boating activities is prevalent in the baseline. Thus, the incremental impact due to PWC use in the park is not all that large. It is expected that with improved technology, quieter PWC will become the standard, and sounds generated by PWC will decrease over time.

Allowing PWC use under Alternatives B, C, and D will impose costs to recreators in the parks, such as canoeists, anglers, birdwatchers, and hikers, relative to baseline conditions. Noise emissions have been identified as a particular nuisance to nonmotorized recreators, such as canoeists and hikers, who tend to place a particularly high value on the tranquility and natural soundscape offered by the parks. Anglers using motorized boats also value the natural soundscape. Therefore, increasing noise from PWC activity in the parks will degrade the experience for both motorized and nonmotorized recreators.

In addition to generating high noise levels, PWC also emit strong-smelling fumes that can be bothersome to other recreators and reduce visibility. These effects tend to be much more localized than noise emissions. Finally, NPS assumes that visibility impacts from emission increases due to allowing PWC under these alternatives will be negligible.

Human Health Costs

PWC emissions contain relatively high levels of pollutants such as VOC, CO, PM, nitrogen oxides (NOx) and hydrocarbons (HCs), which are potentially damaging to human health. It is very unlikely that PWC use in LAME represents a significant health threat to humans; nevertheless, the potential for adverse health effects exists. For example, some of the toxic hydrocarbons are potentially harmful even at very low levels of exposure (EPA, 2000a; EPA, 1999a). The continued use of other motorized watercraft in LAME

means that even if PWC are banned, there would only be a small decrease in emission levels. In summary, the health costs from the regulation are expected to be minor for all of the alternatives.

Ecosystem Degradation Costs

As discussed in Sections 2 and 4.1 of this report, PWC use has the potential to negatively affect ecosystems and natural habitats in a variety of ways. In the case of national parks, these natural resources are of particular value to the public. Although PWC use in LAME is not expected to cause widespread ecosystem damages, allowing PWC in the park can nonetheless cause damage to the welfare of visitors and nonusers by degrading some of the park's natural resources.

Alternative A (No-Action Alternative): This alternative would have no impact on water quality and natural resources relative to baseline conditions.

Alternative B: This alternative would have some negative impact on water quality. However, as discussed in Section 2, allowing PWC under Alternative B is not likely to result in major costs through the degradation of LAME ecosystems.

Alternative C: This alternative would have a slightly larger negative impact on water quality than Alternative B. Fewer spatial restrictions and a more gradual phase-in of cleaner PWC would increase the costs from degraded water quality relative to that alternative. However, the incremental effect would still be small because of the presence of numerous other motorized watercraft in the baseline.

Alternative D: This alternative results in the greatest costs as a result of damages to water quality and LAME ecosystems because PWC are allowed in the park as previously managed without adding geographic restrictions or engine-type restrictions. However, the incremental effect on water quality and LAME ecosystems would still be quite small due to the presence of numerous other motorized watercraft.

As discussed in Section 2.5, the presence of PWC in the park may adversely affect fish and wildlife. In addition to being a potential nuisance to other recreators, noise from PWC may disturb wildlife. Localized, short-term effects on wildlife would occur under

Alternatives B, C, and D by increasing noise disturbance and the chance for collisions with wildlife. There may also be a long-term negative impact to aquatic biota and the ecosystems in the park because of degradation in water quality and an increase in physical disturbances.

Potential harm to the park's ecosystems will degrade the experience of park visitors, for example, by decreasing their chances of viewing wildlife in a natural environment. It will also result in welfare losses to individuals across the country that value the park's unique ecosystems and natural habitats, regardless of whether they actually visit the park. That is, failing to protect the park's ecosystems can result in extensive losses to society.

Safety and Congestion Costs

In addition to environmental costs associated with increases in PWC use, there may also be safety and congestion costs. Since 1990, injuries associated with the recreational use of PWC have increased at least four-fold. The number of injuries reported from PWC use is now higher than that reported from motorboat use in the U.S. (Branche, Conn, and Annest, 1997). Because of the disproportionately large number of injuries associated with PWC use, allowing their use may decrease the safety of park visitors. In addition, the level of congestion is an important factor determining visitor enjoyment. Increases in congestion related to PWC use may therefore have costs to other park users.

Alternative A (No-Action Alternative): This alternative will not result in any costs to society relative to the baseline.

Alternative B: Potential costs resulting from Alternative B include those associated with increases in the risks of PWC-related safety hazards. If Alternative B increases the number of PWC in the park, it may harm all recreators by increasing their risks of being involved in accidents with PWC. These costs are expected to be minor, however. Alternative B might also result in a decrease in PWC use in non-NPS waters (i.e., the Colorado River south of Davis Dam and Lake Havasu) relative to the baseline as PWC users return to LAME for PWC use, decreasing congestion and the chance for safety risks in these areas.

Alternative C: Similar to Alternative B, Alternative C is expected to increase risks of PWC-related safety hazards within LAME and may decrease them outside of NPS waters. Although greater than Alternative B, these costs are still expected to be minor.

Alternative D: Similar to Alternatives B and C, this alternative has the potential to increase PWC-related accidents in NPS waters. However, because congestion might decrease in non-NPS waters, it is possible that accidents could decrease overall.

An increase in PWC-related accidents will also increase the costs to NPS associated with medical/rescue operations.

4.2.4 Benefits

For PWC users who currently ride in LAME or who want to ride in the park in the future, allowing PWC use in the park to continue would result in consumer surplus gains.

PWC users, as well as some businesses in the local area, may experience welfare gains as a result of management alternatives that permit continued PWC usage in the park.

Benefits to PWC Users

Two main groups of PWC users may be affected by the regulations: those who currently use PWC in LAME (prior to the ban) and those who use PWC in substitute areas outside LAME where PWC users displaced from LAME may increase their visitation if PWC use in LAME was banned.

PWC users who currently ride in nearby areas where displaced riders from LAME may have visited will gain some consumer surplus if these areas are less crowded than under baseline conditions due to reauthorizing PWC use in LAME. Although no studies were available that examined the impact of congestion on the value of a PWC trip, other recreation demand studies find that congestion lowers the value of a recreation experience (see Appendix B). For PWC users who ride in LAME or who want to ride in the park in the future, allowing PWC use in the park could result in consumer surplus gains. To the extent that individuals consider other PWC areas, such as those in the nearby area, close substitutes, the change in consumer surplus associated with allowing PWC use in the park will be lower. In the case of LAME, the availability of nearby substitute areas with less stringent regulations is extremely limited (see Section 2.3).

If each individual's demand curve for riding a PWC in LAME were known, then NPS could add up the gain of consumer surplus for

each individual to find the total change in consumer surplus to PWC riders from the management alternatives. Because the demand curve reflects the individual's preferences for available substitute activities and the cost of these activities, measuring the change in consumer surplus from a trip in the park takes into account substitute activities. In this case, NPS does not know the consumer surplus associated with PWC use in LAME, nor does NPS know the riders' next best alternative activities.

To assess the incremental change in consumer surplus for PWC users, NPS used the benefit transfer technique.

To assess the incremental change in consumer surplus for PWC users, NPS used the benefit transfer technique. The benefit transfer methodology has been accepted as an appropriate methodology for estimating natural resource values in other rulemakings (see FAA, 2000). Ideally, a benefit transfer function based on regression analysis of a large number of studies would be used to calibrate existing estimates of consumer surplus for a day of PWC use to conditions in LAME. The benefit transfer function would allow adjustment of consumer surplus to the site quality and typical experience in LAME compared to other nearby areas.

While using benefit transfer saves the time and money required to conduct a study specific to LAME's needs, the ability to use benefit transfer is limited by the availability of appropriate studies. According to regulations for natural resource damage assessment promulgated by the National Oceanic and Atmospheric Administration (NOAA) under the Oil Pollution Act of 1990, transferring values from one study to another is an acceptable methodology provided that the following three basic issues are considered (see Volume 61 of the *Federal Register*, p. 499, published on January 5, 1996):

- comparability of the users and resources/services being valued,
- comparability of the quantity or quality of the resources/services being valued, and
- quality of the selected study.

After conducting an extensive review of the economics literature and consulting with the authors of existing studies, experts in recreation demand analysis at universities, and experts at other consulting firms, NPS was unable to locate a study that estimated the consumer surplus for a PWC trip. A review of the recreation literature conducted by Rosenberger and Loomis (2000) found an

average value of $31.98 (1996 dollars) per person per day for riding in motor boats for the United States (with estimates ranging from $15 to over $50). Bhat et al. (1998) estimate an average consumer surplus of $45.61 (1998 dollars) associated with motorboating and waterskiing in the Rocky Mountains. The same study estimates an average consumer surplus of $28.56 (1998 dollars) associated with motorboating and waterskiing in the Desert Southwest. The region of Nevada where LAME is located was determined by NPS to be between these two eco-regions. Consequently, NPS averaged these two estimates for use in the benefit transfer. Converted to 2001 dollars the average of these two consumer surplus values is $40.21. These estimates come from a travel cost model based on data from the Public Area Recreation Visitors Study (PARVS). The PARVS data was a multiagency survey that included on-site interviews of recreationists at over 350 sites across the U.S. between 1985 and 1992. For the benefit transfer, NPS used the value of $40.21 from Bhat et al. (1998) based on the following criteria:

- Waterskiing and motorboating are similar activities to PWC use.
- The region where the data were collected includes large isolated bodies of water in the Desert Southwest and the Rocky Mountains in the United States, like the lakes at LAME.
- Bhat et al. (1998) was published in a peer-reviewed journal. The authors estimate a travel cost model using data from on-site interviews and only estimate values for activities in a particular region for which at least 100 observations were collected.

Below NPS discusses the estimated impact of each alternative on PWC users.

Alternative A (No-Action Alternative): The no-action alternative would result in a total ban on PWC use in LAME. This would not change regulations relative to baseline conditions, and consequently, would not have any incremental impact on the consumer surplus of any user group.

Alternative B: This alternative would allow PWC in 90 percent of the water portion of the recreation area. In addition, all EPA non-compliant two-stroke PWC would be prohibited from LAME within a year of implementation. NPS expects a large increase in

consumer surplus for PWC users under this alternative relative to baseline conditions.

Alternative C: This alternative would allow PWC in 95 percent of the water portion of the recreation area. In addition, all EPA non-compliant two-stroke PWC would be prohibited from LAME in 2012. NPS expects a large increase in consumer surplus for PWC users under this alternative relative to baseline conditions. The total increase in consumer surplus under this alternative is expected to be larger than under Alternative B because a larger percentage of current PWC users are expected to continue visiting the park for PWC use.

Alternative D: This alternative would result in allowing PWC use in LAME as previously managed. All visitors using PWC in LAME prior to the ban are assumed to regain the full value of their consumer surplus for PWC use in LAME.

Using the value of $40.21 for a day of PWC use, NPS provides an estimate of possible incremental gains in consumer surplus to PWC users as a result of Alternatives B, C, and D.

Using the value of $40.21 for a day of PWC use, NPS provides an estimate of possible incremental gains in consumer surplus to PWC users as a result of Alternatives B, C, and D. NPS assumes that those visitors who return to use PWC in LAME will gain the full value of their consumer surplus. Table 4-4 summarizes the projected consumer surplus gains for PWC users in LAME for Alternatives B, C, and D from 2002 to 2012 and the present value (PV) of these losses using both 3 percent and 7 percent discount rates. The PV is the value of a future stream of benefits or costs, discounted to current years. Under Alternative A, there will be no change in PWC use relative to baseline conditions and therefore no change in consumer surplus derived by PWC users.

Uncertainty: The estimates of consumer surplus gains to PWC users are uncertain for a variety of reasons. Some of the main sources of uncertainty are as follows:

- The estimates of the number of PWC users expected to visit LAME under each of the Alternatives are uncertain, as are the projections of future PWC use.
- The actual consumer surplus associated with PWC use in LAME may be different from the value used in the analysis. The value used in the analysis is based on studies of riding in motor boats and waterskiing in the Desert Southwest and Rocky Mountain ecoregions, which do not include LAME. In addition, the value is based on a full day of motorized water-based recreation. Many PWC users at LAME are

Table 4-4. Projected Incremental Change in Consumer Surplus for PWC Users under Alternatives A, B, C and D, 2002-2012[a]

	Alternative A		Alternative B		Alternative C		Alternative D	
Year	Change in Number of People Using PWC	Change in Consumer Surplus (2001$)	Change in Number of People Using PWC	Change in Consumer Surplus (2001$)	Change in Number of People Using PWC	Change in Consumer Surplus (2001$)	Change in Number of People Using PWC	Change in Consumer Surplus (2001$)
2002[b]	0	$0	0	$0	0	$0	0	$0
2003	0	$0	236,133	$9,514,530	320,467	$12,912,570	337,334	$13,592,180
2004	0	$0	232,710	$9,376,570	315,820	$12,725,340	332,442	$13,395,090
2005	0	$0	229,335	$9,240,610	311,241	$12,540,820	327,622	$13,200,870
2006	0	$0	226,010	$9,106,620	306,728	$12,358,980	322,871	$13,009,450
2007	0	$0	222,733	$8,974,570	302,280	$12,179,780	318,190	$12,820,820
2008	0	$0	219,503	$8,844,440	297,897	$12,003,170	313,576	$12,634,910
2009	0	$0	216,320	$8,716,200	293,578	$11,829,120	309,029	$12,451,710
2010	0	$0	213,184	$8,589,810	289,321	$11,657,600	304,548	$12,271,160
2011	0	$0	210,093	$8,465,260	285,126	$11,488,560	300,132	$12,093,230
2012	0	$0	207,046	$8,342,510	280,991	$11,321,980	295,780	$11,917,870
NPV (3%)[c]	NA	$0	NA	$74,112,030	NA	$100,580,610	NA	$105,874,320
NPV (7%)[d]	NA	$0	NA	$59,006,910	NA	$80,080,800	NA	$84,295,580

[a]All impacts were rounded to the nearest $10. Columns may not sum to totals due to rounding.

[b]It was assumed that there were no incremental impacts in 2002 because any restrictions would not be implemented until after the end of the primary PWC use season.

[c]The economics literature supports a 3 percent discount rate in the valuation of public goods (e.g., Freeman, 1993). Federal rule-makings also support a 3 percent discount rate in the valuation of lost natural resources use (61 FR 453; 61 FR 20584).

[d]Office of Management and Budget (OMB). 2002. "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs: Memorandum for Heads of Executive Departments and Establishments." OMB Circular A-94, revised January 22, 2002.

renters and use PWC for only a small fraction of the day, spending the rest of the day engaged in more traditional beach activities.

- The values in Table 4-4 may overstate true gains under Alternatives B and C because of assumptions about the consumer surplus of PWC users who ride in the park. In the analysis of Alternatives B and C, PWC users who continue to use PWC in LAME may be inconvenienced by the location or engine restrictions. These requirements may decrease the consumer surplus associated with using a PWC in LAME.
- The 1996 EPA Marine Engine Rule may result in lower PWC use if the cost of new machines increases. If fewer riders would visit the park, the incremental consumer surplus gains associated with Alternatives B, C and D would be lower.

Benefits to the Local Area Businesses

If PWC use increases as a result of the regulation, then the suppliers of PWC rental, sales and service will be directly affected. In addition, lodging establishments, restaurants, gas stations, and other businesses that serve PWC riders could experience an increase in business from the regulation. The following section describes the approach used to develop quantitative estimates of these impacts and reports the results of the cost analysis for local area businesses.

PWC Sales and Rental Services. NPS identified 10 PWC rental shops and 9 PWC sales/service shops located in communities near LAME. Five PWC sales/service shops were identified in Las Vegas, NV; three in Bullhead City, AZ; and one in Henderson, NV. Three PWC rental shops were identified in Las Vegas; two in Bullhead City; two in Henderson; one in Overton, NV; one in Searchlight, NV; and one in Boulder City, NV.

NPS contacted some of these firms to gather information relevant to this report and to assess the impact a ban on PWC use in LAME would have on their business. Each firm contacted indicated that their PWC-related business would be severely affected by a ban.

Lodging Establishments, Restaurants, Gas Stations, and Other Businesses. Purchases made by PWC users contribute to total economic activity in the area surrounding LAME. It is very likely that positive localized impacts on tourism-related businesses located near LAME relative to baseline conditions will occur if a PWC management alternative that continues PWC use in LAME is chosen. The management alternatives could affect lodging establishments, restaurants, gas stations, and retail stores in the area.

However, PWC users comprise an extremely small fraction of total economic activity in the area surrounding LAME, which includes Las Vegas, one of the top tourist destinations in the U.S. Park-related revenue from PWC rental shops, PWC sales shops, and PWC servicing shops in the area is approximately $22 million. This figure is quite small compared to the size of the regional economy. In 1999, total personal income in Clark County, NV, was approximately $27 billion (Bureau of Economic Analysis, 2001), much of which is derived from tourism-related businesses. In addition, because most of the PWC owners are believed to be local residents, increases in their visitation to LAME are unlikely to affect sales of tourism-related industries. Because PWC use contributes such a small fraction of regional visitation and expenditures, lodging establishments, restaurants, gas stations, and other businesses that serve PWC riders are not likely to experience a measurable increase in business under any of the alternatives. However, it is possible that localized impacts on tourism-related businesses located near LAME will occur if PWC regulations result in increased visitation to the recreation area. In particular, people might choose to bring their houseboats to LAME if PWC are allowed, which may result in gains to businesses providing goods and services to houseboat owners. Expenditures by houseboat owners are substantial. Houseboat mooring fees alone can be upwards of $20,000 per year. However, based on conversations with local firms, it appears unlikely that a substantial number of houseboat owners would choose to stop visiting LAME if PWC use were restricted. One person that moors houseboats indicated that in the baseline, under a ban, he may lose 2 to 3 percent of his current (pre-ban) mooring business, while other firms interviewed generally felt losses in houseboat revenues under the baseline would be smaller than that.

Based on the existing data and interviews with local businesses, Alternatives B, C, and D will result in sizeable increases in PWC-related revenue, although not enough to result in measurable impacts at the regional level. The expected increases are described in Section 3.1. Based on the scenarios outlined in Section 3.1 for each of the alternatives, NPS calculated potential revenue gains (see Table 3-4).

To translate changes in revenue into producer surplus for purposes of benefit-cost analysis, NPS used estimates of the increase in

revenue associated with the rule and return-on-sales measures for the relevant Standard Industrial Classification (SIC) codes. The use of this profit margin only approximates gains in producer surplus. Producer surplus captures the difference between marginal costs and marginal revenue, while return on sales contains other measures reflecting fixed costs, taxes, and/or accounting conventions rather than measures of marginal profits. For this reason, the use of Dun & Bradstreet accounting profit margin data may understate producer surplus gains.

The profit ratios, net profit after tax divided by sales, come from D&B (2001).[4] For instance, the upper quartile profit ratio for sales shops is 4.6 percent and the lowest quartile is 0.6 percent. For rental shops, the upper quartile profit ratio is 8.7 percent and the lowest quartile is –3.4 percent. However, none of the rental shops that NPS interviewed indicated that they had a negative profit margin. Therefore, NPS used the median profit ratio (3.9 percent) in this analysis rather than the lowest quartile. Estimated profit ratios for each of the industries expected to be directly affected by PWC restrictions in LAME are provided in Table 4-5.

Table 4-5. Profit Ratios Used for Calculating Producer Surplus Losses

	Profit Ratios		
	SIC	**Bottom Quartile**	**Upper Quartile**
PWC rentals	7999	3.9%	8.7%
PWC sales	5571	0.6%	4.6%
PWC storage	7999	3.9%	8.7%
Restaurants and bars	5812	0.6%	7.5%
Grocery stores	5411	0.4%	3.0%
Gas and oil	5541	0.1%	3.1%
Souvenir shops and other retail establishments	5947	1.1%	9.9%

[4]Dun & Bradstreet data for NAICS codes are not currently available. Therefore, NPS used the comparable SIC code 5571 (Motorcycle Dealers) as defined by the U.S. Census (i.e., SIC 5571, Motorcycle Dealers) for PWC dealerships. For rental shops, NPS used SIC code 7999 (Amusement and Recreation NEC).

For businesses in the LAME region, estimated producer surplus gains relative to the baseline associated with imposing Alternatives B, C, or D are presented in Table 4-6.[5] There are no producer surplus losses expected under Alternative A. The majority of the estimated producer surplus gains occur in the PWC sales/service and rental and other retail markets under Alternatives B, C, and D. For Alternative B, estimated producer surplus gains range from $84,230 to $645,780 for PWC sales/service and from $127,950 to $285,430 for PWC rentals depending on the profit ratio chosen. For Alternative C, estimated producer surplus gains range from $89,190 to $683,770 for PWC sales/service and from $173,650 to $387,370 for PWC rentals. Under Alternative D, producer surplus gains are estimated to range from $94,140 to $721,750 for PWC sales/service and $182,790 to $407,750 for PWC rentals. The range of gains predicted for the other business categories, which include restaurants and bars, groceries/take-out, gasoline and oil, and souvenir/retail shops is between $830 and $252,410 depending on the business category, the alternative, and the profit ratio used. Overall, producer surplus gains are estimated to be from $260,890 to $1.44 million under Alternative B, $318,110 to $1.65 million under Alternative C, and $333,500 to $1.72 million under Alternative D.

Table 4-6. Changes in Producer Surplus in the First Year Resulting from PWC Use Management Alternatives in LAME (2001$)[a]

	Alternative B		Alternative C		Alternative D	
	Low	**High**	**Low**	**High**	**Low**	**High**
PWC rentals	$127,950	$285,430	$173,650	$387,370	$182,790	$407,750
PWC sales/service	$84,230	$645,780	$89,190	$683,770	$94,140	$721,750
Lodging	$12,570	$142,100	$14,380	$162,600	$14,740	$166,700
Restaurants and bars	$8,310	$103,850	$9,510	$118,860	$9,750	$121,870
Groceries/take-out	$2,610	$19,580	$2,990	$22,410	$3,060	$22,980
Gas and oil	$830	$25,750	$950	$29,470	$970	$30,220
Souvenirs and other retail	$24,390	$219,480	$27,440	$246,920	$28,050	$252,410
Total	**$260,890**	**$1,441,970**	**$318,110**	**$1,651,400**	**$333,500**	**$1,723,680**

[a]All impacts were rounded to the nearest $10. Columns may not sum to totals due to rounding.

[5]Estimated producer surplus gains in future years have a similar distribution across industries.

Table 4-7 summarizes the estimated change in producer surplus for the period from 2002-2012. There is no change in producer surplus relative to the baseline under Alternative A. The present value of incremental increases in producer surplus for Alternative B is $2.03 million to $11.23 million using a 3 percent discount rate and $1.62 million to $8.94 million using a 7 percent discount rate. For Alternative C, the present value of producer surplus gains is estimated to be $2.48 to $12.86 million using a 3 percent discount rate and $1.97 to $10.24 million using a 7 percent discount rate. Alternative D has an estimated present value for producer surplus increases of $2.60 to $13.43 million with a 3 percent discount rate and $2.07 to $10.69 million when a 7 percent discount rate is used.

Uncertainty

A number of factors will affect local business revenues and the resulting estimates of changes in producer surplus associated with the alternatives. Important factors include the uncertainty surrounding the baseline projections as described in Section 2.2, uncertainty concerning the estimation of output reductions as described in Section 3.3.8, and the use of national average accounting profit ratios to approximate producer surplus gains to individual local businesses.

NPS Enforcement Costs

In addition to costs incurred by PWC users and local businesses under regulation, costs are expected to be incurred by taxpayers to support an increase in enforcement efforts by park staff. The cost of enforcement for new PWC regulations in LAME is estimated using the number of additional staff members in terms of full-time equivalents (FTEs) that will be devoted to enforcement of PWC regulations under each regulatory alternative and the General Schedule (GS) level for these FTEs. The salary rates are taken from the 2003 General Schedule Locality Rates of Pay for Rest of U.S. (OPM, 2003), which presents pay rates by GS level and step. For this analysis, a Step 5 is assumed for all FTEs.

The LAME LMP EIS (NPS, 2002a) estimates the number of additional enforcement personnel that would be required under each regulatory alternative. It was estimated that Alternatives A, B, C, and D would require 0, 42, 50, and 62 incremental enforcement

Table 4-7. Changes in Producer Surplus Resulting from PWC Use Management Alternatives in LAME, 2002-2012[a] (2001$)

Year	Alternative B		Alternative C		Alternative D	
	Low	High	Low	High	Low	High
2002[b]	$0	$0	$0	$0	$0	$0
2003	$260,890	$1,441,970	$318,110	$1,651,400	$333,500	$1,723,680
2004	$257,110	$1,421,060	$313,500	$1,627,450	$328,660	$1,698,690
2005	$253,380	$1,400,450	$308,950	$1,603,850	$323,890	$1,674,060
2006	$249,710	$1,380,140	$304,470	$1,580,590	$319,190	$1,649,790
2007	$246,090	$1,360,130	$300,060	$1,557,670	$314,560	$1,625,870
2008	$242,520	$1,340,410	$295,710	$1,535,080	$310,000	$1,602,290
2009	$239,000	$1,320,970	$291,420	$1,512,820	$305,510	$1,579,060
2010	$235,530	$1,301,820	$287,190	$1,490,880	$301,080	$1,556,160
2011	$232,110	$1,282,940	$283,030	$1,469,260	$296,710	$1,533,600
2012	$228,740	$1,264,340	$278,930	$1,447,960	$292,410	$1,511,360
PV (3%)[c]	**$2,031,990**	**$11,232,060**	**$2,477,690**	**$12,863,370**	**$2,597,680**	**$13,426,400**
PV (7%)[d]	**$1,617,850**	**$8,942,800**	**$1,972,710**	**$10,241,630**	**$2,068,240**	**$10,689,900**

[a]All impacts were rounded to the nearest $10. Columns may not sum to totals due to rounding.

[b]It was assumed that there were no incremental impacts in 2002 because any restrictions would not be implemented until after the end of the primary PWC use season.

[c]The economics literature supports a 3 percent discount rate in the valuation of public goods (e.g., Freeman, 1993). Federal rule-makings also support a 3 percent discount rate in the valuation of lost natural resources use (61 FR 453; 61 FR 20584). While the welfare impacts in this case are for private goods, the 3 percent discount rate was used to be consistent with discounting of other impacts in this report.

[d]Office of Management and Budget (OMB). 2002. "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs: Memorandum for Heads of Executive Departments and Establishments." OMB Circular A-94, revised January 22, 2002.

personnel, respectively.[6] However, these estimates include staff for enforcement of many activities other than PWC use in the park, such as enforcement of sanitation and alcohol use regulations. In addition, the estimated number of additional enforcement staff needed for enforcing new recreational zoning is for all park visitors, not just PWC users. Based on information obtained from LAME, law enforcement rangers at the park typically spend approximately 50 percent of their time on land issues and 50 percent on water

[6]For Alternatives B, C, and D, the number of incremental enforcement personnel presented includes 40 staff members that the park estimates are necessary to adequately enforce current LAME rules and regulations (i.e., they are currently understaffed) plus incremental staff members needed for adequate enforcement of new rules and regulations under the LMP alternatives.

issues. Of the 50 percent spent on water issues, approximately 30 percent of their time is spent dealing with PWC-related issues. Therefore, approximately 15 percent of their total time is spent on PWC issues (Holland, 2003). Assuming that the incremental enforcement personnel needed under each alternative in the LMP would have their time distributed in the same manner, this implies that the number of FTEs devoted to PWC issues under Alternatives A, B, C, and D would be 0, 6.3, 7.5, and 9.3, respectively.

Typical wage rates for law enforcement rangers at LAME are at the GS-9 level (Holland, 2003). Assuming a Step 5 level for each, the annual pay rate is $43,733 (OPM, 2003). Using an average benefits level of 32 percent of pay and an average overhead level of 17 percent of pay and benefits, the fully loaded annual cost per law enforcement ranger at LAME is approximately $67,541. Multiplying the number of FTEs devoted to PWC enforcement by this average annual cost per FTE for each alternative yields the estimated incremental PWC enforcement cost. Table 4-8 presents the incremental annual cost and present value of enforcing new PWC regulations, assuming that the real annual cost per law enforcement ranger at LAME and the number of rangers devoted to PWC-related issues remain constant over time.

Uncertainty: The estimates of incremental LAME enforcement costs for PWC-related issues are uncertain for a variety of reasons, including

- The proportion of enforcement time devoted to PWC-related issues may differ after implementation of a new regulation relative to current conditions.
- Although the LAME LMP EIS (NPS, 2002a) provides estimates of the number of FTEs required under each alternative, there is no guarantee that enough resources will be made available to fund all of these new positions. Given that the EIS determines that LAME is already significantly understaffed, it is likely that actual enforcement costs will be less than estimated above because insufficient resources will be available to hire this many new staff.

Table 4-8. Incremental NPS Enforcement Costs Resulting from Restrictions on PWC Use in LAME, 2002–2012[a] (2001$)

	Alternative A	Alternative B	Alternative C	Alternative D
Year	Low	Low	Low	Low
2002[b]	$0	$0	$0	$0
2003	$0	$425,508	$506,558	$628,131
2004	$0	$425,508	$506,558	$628,131
2005	$0	$425,508	$506,558	$628,131
2006	$0	$425,508	$506,558	$628,131
2007	$0	$425,508	$506,558	$628,131
2008	$0	$425,508	$506,558	$628,131
2009	$0	$425,508	$506,558	$628,131
2010	$0	$425,508	$506,558	$628,131
2011	$0	$425,508	$506,558	$628,131
2012	$0	$425,508	$506,558	$628,131
PV (3%)[c]	**$0**	**$3,523,950**	**$4,195,180**	**$5,202,030**
PV (7%)[d]	**$0**	**$2,793,080**	**$3,325,090**	**$4,123,110**

[a]All impacts were rounded to the nearest $10. Columns may not sum to totals due to rounding.

[b]It was assumed that there wee no incremental impacts in 2002 because any restrictions would not be implemented until after the end of the primary PWC use season.

[c]The economics literature supports a 3 percent discount rate in the valuation of public goods (e.g., Freeman, 1993). Federal rule-makings also support a 3 percent discount rate in the valuation of lost natural resources use (61 FR 453; 61 FR 20584).

[d]Office of Management and Budget (OMB). 2002. "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs: Memorandum for Heads of Executive Departments and Establishments." OMB Circular A-94, revised January 22, 2002.

4.3 SUMMARY

Alternative A, the no action alternative, represents the baseline for this analysis. Under that alternative, all PWC use would be prohibited from the park. Alternatives B and C would permit PWC use with certain restrictions, and Alternative D would permit PWC use as currently managed in the park (pre-ban). The benefits of any alternative are measured relative to the baseline conditions, which are represented by Alternative A. Therefore, there are no incremental benefits associated with Alternative A. The primary beneficiaries of Alternatives B, C, and D would be the park visitors who use PWC and the businesses that provide services to PWC

users such as rental shops, restaurants, gas stations, and hotels. Additional beneficiaries include individuals who use PWC outside the park where PWC users displaced from the park may decide to ride if PWC use within the park were prohibited. Benefits accruing to individual PWC users are called consumer surplus gains, and those accruing to businesses are called producer surplus gains. Consumer surplus measures the net economic benefit obtained by individuals from participating in their chosen activities, while producer surplus measures the net economic benefit obtained by businesses from providing services to individuals. These benefits, projected over a 10-year horizon, are summarized in Table 4-9.

Table 4-9. Present Value of Projected Incremental Benefits Under Alternatives B, C, and D, 2002–2012

	PWC Users	Businesses	Total
Alternative B			
Discounted at 3%	$74,112,030	$2,031,990–$11,232,060	$76,144,020–$85,344,090
Discounted at 7%	$59,006,910	$1,617,850–$8,942,800	$60,624,760–$67,949,710
Alternative C			
Discounted at 3%	$100,580,610	$2,477,690–$12,863,370	$103,058,300–$113,443,980
Discounted at 7%	$80,080,800	$1,972,710–$10,241,630	$82,053,510–$90,322,430
Alternative D			
Discounted at 3%	$105,874,320	$2,597,680–$13,426,400	$108,472,000–$119,300,720
Discounted at 7%	$84,295,580	$2,068,240–$10,689,900	$86,363,820–$94,985,480

As with the benefits described above, the costs of any alternative are measured relative to the baseline conditions, which are represented by Alternative A. Therefore, there are no incremental costs associated with Alternative A. The primary group that would incur costs under Alternatives B, C, and D are the park visitors who do not use PWC and whose park experiences would be negatively affected by PWC use within the park. At Lake Mead, non-PWC uses include boating, canoeing, fishing, and hiking. Additionally, the public could incur costs associated with impacts from Alternatives B, C, and D to aesthetics, ecosystem protection, human health and

safety, congestion, and non-use values. However, these costs could not be quantified due to a lack of available data.

There are other costs associated with Alternatives B, C, and D relating to NPS enforcement of PWC restrictions. Those costs, projected over a 10-year horizon, are summarized in Table 4-10.

Table 4-10. Present Value of Projected NPS Enforcement Costs Under Alternatives B, C, and D, 2001–2012

Alternative B	
Discounted at 3%	$3,523,950
Discounted at 7%	$2,793,080
Alternative C	
Discounted at 3%	$4,195,180
Discounted at 7%	$3,325,090
Alternative D	
Discounted at 3%	$5,202,030
Discounted at 7%	$4,123,110

The quantified net benefits associated with Alternatives B, C, and D are presented in the table below. These net benefits do not account for the costs to non-PWC users, or those relating to aesthetics, ecosystem protection, human health, and safety, congestion, or non-use values due to a lack of available data. Therefore, these net benefit estimates do not represent all costs. If all costs could be incorporated, the indicated net benefits for each alternative would be lower. Nevertheless, these estimates present a likely range of net benefits that can be estimated from available information.

From an economic perspective, the selection of Alternative C as the preferred alternative was considered reasonable because certain costs could not be quantified in the net benefits presented above. Those costs, relating to non-PWC use, aesthetics, ecosystem protection, human health and safety, congestion, or non-use values, would likely be greater for Alternative D than for Alternative C. Given that the quantified net benefits of Alternatives C and D are already similar (see Table 4-11), further inclusion of these un-quantified costs could reasonably result in Alternative C having the greatest level of net benefits. Therefore, based on these factors,

Table 4-11. Present Value of Quantified Net Benefits Under Alternatives B, C, and D, 2002–2012

Alternative B	
Discounted at 3%	$72,620,070–$81,820,140
Discounted at 7%	$57,831,680–$65,156,630
Alternative C	
Discounted at 3%	$98,863,120–$109,248,800
Discounted at 7%	$78,728,420–$86,997,340
Alternative D	
Discounted at 3%	$103,269,970–$114,098,690
Discounted at 7%	$82,240,710–$90,862,370

Alternative C was considered to provide the greatest level of net benefits.

5 Small Entity Impact Analysis

Alternatives B, C, and D are expected to have positive effects on small businesses relative to baseline conditions.

The regulations potentially affect the economic welfare of a number of businesses, large and small. However, small entities may have special problems in complying with such regulations. The Regulatory Flexibility Act (RFA) of 1980, as amended in 1996, requires special consideration be given to these entities during the regulatory process.

To fulfill these requirements, agencies must perform a review to determine whether a proposed or final rule will have a significant economic impact on a substantial number of small entities. This section assesses the potential for PWC regulations in LAME to affect small businesses. Expected changes in revenues across firms and regional economic impacts are discussed in Section 3 and expected changes in producer surplus are discussed in Section 4.

5.1 IDENTIFYING SMALL ENTITIES

As described in Sections 2 and 3, NPS attempted to identify the firms in the region surrounding LAME that would experience the most significant impacts as a result of PWC regulations in LAME. NPS identified 10 PWC rental shops and 9 PWC sales/service shops located in communities near LAME. Five PWC sales/service shops were identified in Las Vegas, NV; three in Bullhead City, AZ; and one in Henderson, NV. Three PWC rental shops were identified in Las Vegas; two in Bullhead City; two in Henderson; one in Overton, NV; one in Searchlight, NV; and one in Boulder City, NV.

NPS computed total revenue for each firm in one of the following ways:

- Interview Data—For PWC dealerships that provided an estimate of the number of PWC sold, NPS multiplied that estimate by the average price ($7,828) of PWC (NMMA, 2002c) to obtain PWC revenue. NPS divided this value by the proportion of total revenue that the dealership indicated was derived from PWC sales to obtain an estimate of total firm revenue.

- *Info*USA Data—NPS used the midpoint of the sales range reported for the firm (*Info*USA, 2002).

Based on this approach, NPS estimated these 19 firms had a total of approximately $118 million in annual revenue.

Based on comments received from these businesses, PWC are sold year-round with the majority of the sales in the late spring/early summer. Interview data suggest that the PWC dealerships near LAME have other sources of revenue besides PWC sales. Some of the PWC dealerships sold items such as motorcycles, boats (other than PWC), motor scooters, ATVs, trailers, generators, and outboard motors. Most of the firms contacted that rent PWC said PWC rentals are their primary source of revenue but that they have other sources of revenue as well.

Each business contacted implied that its business would be severely affected (relative to pre-ban conditions) if the park decided to ban PWC from LAME. Under the baseline scenario, PWC would be banned from LAME on April 10, 2003. Based on information gathered from local businesses, NPS assumed that banning PWC from LAME would result in a 100 percent reduction in rental revenues and a 95 percent reduction in PWC sales/service revenues relative to current conditions. Alternative B allows continued PWC use with restrictions on area of use and PWC engine type. Approximately 10 percent of the lake area will be closed to PWC and PWC with conventional two-stroke engines will be banned from LAME. NPS assumed rental revenues would decline by 30 percent and sales/service revenues would decline by 10 percent under this alternative relative to pre-ban conditions. Alternative C also allows continued PWC use with additional restrictions, although these restrictions are less stringent than those imposed under Alternative B. This alternative closes approximately 5 percent of the lake area to PWC and bans conventional two-stroke engines from LAME beginning in 2012. Under Alternative C, NPS assumed a 5 percent reduction in rental and sales/service revenues relative to

pre-ban conditions. Alternative D authorizes continued PWC use as managed prior to a ban on PWC use in LAME, resulting in no change in revenues for PWC-related businesses relative to conditions prior to a ban on PWC use in LAME. Because the baseline for this analysis is a ban, Alternative A, the no-action alternative, has no incremental impacts on small businesses, while Alternatives B, C, and D have large positive impacts because they allow small businesses to avoid the reductions in revenue that would otherwise occur in the baseline.

In addition to businesses offering PWC sales and service or rental services, the restrictions could potentially affect other businesses such as lodging establishments, restaurants, gas stations, and retail stores in the area. These establishments may be affected if the restrictions lead to changes in visitation to the park and surrounding area. However, relative to the no-action baseline, these businesses are expected to see an increase in revenues under Alternatives B, C, and D.

5.2 ASSESSMENT

After considering the economic impacts of the PWC regulations in LAME on small entities, NPS concludes that none of the alternatives will have a significant negative impact on a substantial number of small businesses. In fact, Alternatives B, C, and D will have a positive impact on small businesses in the LAME region relative to the baseline scenario, which bans PWC from LAME in April 2003. The no-action alternative will not have a significant impact on a substantial number of small entities because it will not result in a change from baseline conditions. It is possible that Alternatives B, C, and D could result in a decrease in revenues for businesses that cater to non-PWC users if visitation by non-PWC users is reduced relative to baseline conditions. However, any net losses to individual businesses under this rule are expected to be very small, especially because many local businesses derive revenue from both PWC users and non-PWC users. Overall, small business revenues are expected to be higher than under baseline conditions. NPS made the determination that these management alternatives would not have a significant negative impact on small entities using RFA implementation guidance provided by other agencies (NMFS, 2000;

EPA, 1999b; SBA, 1998) and provides the following factual basis for this determination:

Does the rule have a significant impact on a substantial number of small entities?

Alternative A: No

Alternative B: No

Alternative C: No

Alternative D: No

- NPS projects no change in revenue for local small businesses relative to baseline conditions under Alternative A, the no-action alternative.
- NPS projects higher total levels of revenue relative to the no-action baseline for firms selling and renting PWC to LAME visitors under Alternatives B, C, and D.
- NPS projects higher overall levels of revenue for other businesses (including hotels, restaurants, grocery stores, gas stations, and souvenir shops) in the LAME region relative to the no-action baseline under Alternatives B, C, and D.

References

Arfsten, D.P., D.J. Schaeffer, and D.C. Mulveny. 1996. "The Effects of Near Ultraviolet Radiation on the Toxic Effects of Polycyclic Aromatic Hydrocarbons in Animals and Plants: A Review." *Ecotoxicology and Environmental Safety* 33:1-24

Baldwin, M.F. 1970. *The Off-Road Vehicle and Environmental Quality*. Washington, DC: The Conservation Foundation.

Beal, Diana J. 1994. "Campers' Attitudes to Noise and Regulation in Queensland National Parks." *Australian Parks and Recreation* 30(4):38-40.

Bhat, G., J. Bergstrom, R. Teasley, J.M. Bowker, and H. Ken cordell. 1998. "An Ecoregional Approach to the Economic Valuation of Land- and Water-Based Recreation in the United States." *Environmental Management* 22(1):69-77.

Boardman, A.E., D.H. Greenberg, A.R. Vining, and D.L. Weimer. 1996. *Cost-Benefit Analysis: Concepts and Practice*. Upper Saddle River, NJ: Prentice Hall, Inc.

Bram, Jason. 1995. "Tourism and New Yorl City's Economy." *Current Issues in Economics and Finance* 1(7):1-6.

Branche, C.M., J.M. Conn, and J.L. Annest. 1997. "Personal Watercraft-Related Injuries: A Growing Public Health Concern." *Journal of the American Medical Association* 278(8):663-665.

Burger, J. 1998. "Effects of Motorboats and Personal Watercraft on Flight Behavior Over a Colony of Common Tern." *The Condor* 100(3):528-534.

Bury, R.B., and R.A. Luckenbach. 1983. "Vehicular Recreation in Arid Land Dunes: Biotic Responses and Management." In *Environmental Effects of Off-Road Vehicles: Impacts and Management in Arid Regions*, R.H. Webb and H.G. Wilshire, eds., pp. 207-221. New York: Springer-Verlag.

Bury, R.L., R.C. Wendling, and S.F. McCool. 1976. *Off-Road Recreation Vehicles—A Research Summary 1969-1975*. Report MP1277. College Station, TX: The Texas Agricultural Experiment Station.

California Air Resources Board. 1999. "Fact Sheet: New Regulations for Gasoline Marine Engines." <http://www.arb.ca.gov/msprog/marine/facts.pdf>. As obtained on December 10, 2001.

Chestnut, L.G., and R.D. Rowe. 1990. *Preservation Values for Visibility Protection at the National Parks: Draft Final Report*. Prepared for the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC.

Dun & Bradstreet. 2001. *Industry Norms & Key Business Ratios. Desk-Top Edition*. Murray Hill, NJ: D&B.

Dunn, D.R. 1970. "Motorized Recreational Vehicles—On Borrowed Time." *Parks and Recreation* 5(7):10-14, 46-52.

Federal Aviation Administration (FAA). January 2000. *Regulatory Evaluation, Regulatory Flexibility Analysis, International Trade Impact Assessment, and Unfunded Mandates Assessment: Commercial Air Tour Limitation in the Grand Canyon National Park Special Flight Rules Area*. Washington, DC: FAA.

Federal Register. 1996. "Environmental Protection Agency: 40-CFR, parts 89, 90 and 91. Air Pollution Control; Gasoline Spark Ignition Marine Engines; New Nonroad Compression-Ignition and Spark Ignition Engines, Exemptions; Rule." *Federal Register* 61(194). October 4, 1996.

Freeman, III, A.M. 1993. *The Measurement of Environmental and Resource Values: Theory and Methods*. Washington, DC: Resources for the Future.

Freeman, A.M. 1995. "The Benefits of Water Quality Improvements for Marine Recreation: A Review of the Empirical Evidence." *Marine Resource Economics* 10:385-406.

Graefe, Alan R., and Jim Holland. 1997. *An Analysis of recreational Use and Assocaited Impacts at Lake Mead National Recreation Area: A Social and Environmental Perspective*. Final report submitted to the National Park Service.

Hagler Bailly. 1999. *State of Nevada Watercraft Use Study Nevada Lakes Final Report*. Madison, WI: Hagler Bailly.

Holland, Jim, NPS. March 2002. Personal communication with Maggie Branton, ARCADIS JSA.

Holland, Jim, NPS. January 9, 2003. Personal communication with Bruce Peacock, NPS.

*Info*USA. 2002. "*Reference*USA: An *Info*USA Service." <http://www.referenceUSA.com>. As obtained in June 2002.

Ivy, M. I., Stewart, W., and Lue, C. 1992. "Exploring the Role of Tolerance in Recreational Conflict." *Journal of Leisure Research* 24:348-360.

Kado, N.Y., R.A. Okamoto, J. Karim, and P. A. Kuzmicky. 2000. Airborne Particle Emissions from 2- and 4-Stroke Outboard Marine Engines: Polycyclic Aromatic Hydrocarbon and Bioassay Analyses." *Environ. Sci. Technol.* 34:2714-2720.

Komanoff, Charles, and Howard Shaw. 2000. "Drowning in Noise: Noise Costs of Jet Skis in America." <http://www.nonoise.org/library/drowning/drowning.htm>.

League for the Hard of Hearing. "Noise Center of the League: Recreational Noise Fact Sheet." <http://www.lhh.org/noise/facts/recreation.htm>. As obtained in October 2000.

Lucas, R.C., and G.H. Stankey. 1974. "Social Carrying Capacity for Back-Country Recreation." In *Outdoor Recreation Research: Applying the Results*. pp. 14-23. Report 6TR-NC9. USDA Forest Service

Malm, William C. 1999. *Introduction to Visibility*. Prepared under Cooperative Agreement CA2350-97-001: T097-04, T098-06. Fort Collins, CO: Cooperative Institute for Research in the Atmosphere, NPS Visibility Program.

Mekenyan, O.G., G.T. Ankley, G.D. Veith, and D.J. Call. 1994. "QSARs for Photoinduced Toxicity 1. Acute Lethality of Polycyclic Aromatic Hydrocarbons to Daphnia magna." *Chemosphere* 28:567-582.

Michael, Jeffrey A., and Stephen D. Reiling. 1997. "The Role of Expectations and Heterogenous Preferences for Congestion in the Valuation of Recreation Benefits." *Agricultural and Resource Economics Review* 27(October):166-173.

Money Generation Model—Version 2 (MGM2). 2002. <http://www.msu.edu/user/stynes/npsmgm/>. As obtained July 2002.

National Center for Environmental Research (NCER), J.T. Oris, S.I. Guttman, and G.A. Burton. 1999. *Ecological Assessment of the Photoxic Polycyclic Aromatic Hydrocarbon Fluoranthene in Freshwater Systems*, EPA Grant Number R823873**)**.

National Marine Fisheries Service (NMFS). Guidelines for Economic Analysis of Fishery Management Options. <http://www.nmfs.noaa.gov/sfa/prorules.html>. Last updated August 2000.

National Marine Manufacturers Association (NMMA). 2002a. "2001 Population Estimates." *Boating 2001.* National Marine Manufacturers Association. <www.nmma.org>. As obtained July 11, 2002.

National Marine Manufacturers Association (NMMA). 2002b. "Annual Retail Unit sales Estimates." *Boating 2001.* National Marine Manufacturers Association. <www.nmma.org>. As obtained July 11, 2002.

National Marine Manufacturers Association (NMMA). 2002c. "The Boating Market." *Boating 2001.* National Marine Manufacturers Association. <www.nmma.org>. As obtained December 2, 2002.

National Park Service (NPS). 1999. *Statistical Abstract 1999*. Denver, CO: National Park Service.

National Park Service (NPS). February 2000a. *Air Quality Concerns Related to Snowmobile Usage in National Parks*. Denver, CO: National Park Service.

National Park Service (NPS). "Effects of Visual Air Quality on Visitor Experience." <http://www2.nature.nps.gov/ard/vis/visitexp.htm>. As obtained on October 25, 2000b.

National Park Service (NPS). 2001. *Personal Watercraft Use, Draft Environmental Assessment: Big Thicket National Preserve*. Denver, CO: National Park Service.

National Park Service (NPS). 2002a. *Environmental Impact Statement for the Implementation of the Lake Management Plan Lake Mead National Recreation Area*. Denver, CO: National Park Service.

National Park Service (NPS). "Visitation Records." <http://www.nps.gov>. As obtained in March 2002b.

National Transportation Safety Board (NTSB). 1998. *Personal Watercraft Safety*. Safety Study NTSB/SS-98/01. Washington, DC.

Office of Management and Budget (OMB). 1992. Regulatory Impact Guidance. Appendix V of Regulatory Program of the United States Government. April 1, 1991–March 31, 1992.

Office of Management and Budget (OMB). 2002. "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs: Memorandum for Heads of Executive Departments and Establishments." OMB Circular A-94, revised January 22, 2002.

Office of Personnel Management (OPM). 2003. Salary Table 2003-RUS. <http://www.opm.gov/oca/03tables/pdf/RUS/pdf>. As obtained on January 10, 2003.

O'Riordan, T. 1977. "Sharing Waterspace: How Coarse Fish Anglers and Boat Users React to One Another." *Proceedings of the Recreational Freshwater Conference*. UK: Water Research Centre.

Oris, J.T., A.C. Hatch, J.E. Weinstein, R.H. Findlay, P.J. McGinn, S.A. Diamond, R. Garrett; W. Jackson, G.A. Burton, and B. Allen. 1998. "Toxicity of Ambient Levels of Motorized Watercraft Emissions to Fish and Zooplankton in Lake Tahoe, California/Nevada, USA." Poster number 3E-P005, presented at the 8th Annual Meeting of the European Society of Environmental toxicology and Chemistry (SETAC-Europe), Bordeaux, France.

Overseas Marketing Group (OMGSIC). Hearing Problems and Diseases. <http://www.omgsic.com/2.4v.htm.>. As obtained on October 9, 2000.

Pearce, D., and D. Moran. 1994. *The Economic Value of Biodiversity*. London: Earthscan Publication.

Personal Watercraft Industry Association (PWIA). 2002. <http://www.pwia.org/Abo_PWC.htm.> As obtained on January 23, 2002.

Rodgers, J.A., and H.T. Smith. 1997. "Buffer Zone Distances to Protect Foraging and Loafing Waterbirds from Disturbance by Personal Watercraft in Florida." *Wildlife Society Bulletin* 25(1):139-145.

Rosenberger, Randall, and John Loomis. 2000. "Using Meta-Analysis for Benefit Transfer: In-Sample Convergent Validity Tests of an Outdoor Recreation Database." *Water Resources Research* 36(4):1097-1107.

Schmidt, M., U.S. Coast Guard. September 4, 2001. Personal communication with RTI.

Sheridan, D. 1979. *Off-Road Vehicles on Public Land*. Washington, DC: Council on Environmental Quality.

Stynes, Daniel. 2000. "Economic Impacts of Tourism." <http://www.msu.edu/course/prr/840/econimpact/pdf/ecimpvol1.pdf>. As obtained on October 15, 2000.

Tjarnlund, U. and G. Ericson. 1995. "Investigation of the Biological Effects of 2-cycle Outboard Engines' Exhaust on Fish." *Marine Environmental Research Series* 39: 313:316.

Tjarnlund, U., G. Ericson, E. Lindesjoo, I. Petterson, G. Akerman, and L. Balk. 1996. "Further Studies of the Effects of Exhaust from Two-Stroke Outboard Motors on Fish." *Marine Environmental Research* 42(1):267-271.

U.S. Bureau of Census. 2002. Statistics by Economic Sub-sector, Clark County Nevada and Mojave County, AZ. 1997 Economic Census. <http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=ECN&_lang=en>. Accessed December 4, 2002.

U.S. Bureau of Economic Analysis (BEA). July 1995. U.S. Department of Commerce, BEA Regional and State Projections of Economic Activity and Population to 2045: Volume 1: States, Washington, DC.

U.S. Bureau of Economic Analysis. 2001. "Bearfacts: Clark, Nevada, 1998-99." Last updated October 24, 2001.

U.S. Bureau of Economic Analysis (BEA). 2002. U.S. Department of Commerce, Regional Accounts Data. "Bearfacts." <http://www.bea.gov/bea/regional/bearfacts/>.

U.S. Bureau of Labor Statistics. 2000. Consumer Price Index. Series CUUR000SA0. <http://146.142.24/cgi-bin/surveymost.>. As obtained on October 26, 2000.

U.S. Bureau of Labor Statistics. 2002. Consumer Price Index. Series ID CUUR000SA0. <http://146.142.24/cgi-bin/surveymost>. As obtained on January 23, 2002.

U.S. Environmental Protection Agency (EPA). 1974. "Information on the Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety." EPA 550/9-74-004, U.S. EPA, Washington D.C.

U.S. Environmental Protection Agency (EPA). 1993. EPA Fact Sheet: Automobiles and Ozone. <http://www.epa.gov/otaq/04-ozone.htm>.

U.S. Environmental Protection Agency (EPA). 1994. "The Effects of Marine Engine Exhaust Emissions on Water Quality: Summary of Findings of Various Research Studies." Office of Air and Radiation.

U.S. Environmental Protection Agency (EPA). 1996a. "Air Pollution Control: Gasoline Spark-Ignition Marine Engines: New Nonroad Compression-Ignition and Spark-Ignition Engines, Exemptions; Rule." *Federal Register* 61(October 4):52087-106.

U.S. Environmental Protection Agency (EPA). 1996b. "Final Rule for New Gasoline Spark-Ignition Marine Engines." 61(194). Washington, DC: U.S. EPA.

U.S. Environmental Protection Agency (EPA). 1997. "Control of Air Pollution: Amendment to Emission Requirements Applicable to New Gasoline Spark-Ignition Engines." *Federal Register* 62(April 2):15805-08.

U.S. Environmental Protection Agency (EPA). 1999a. *1997 National Air Quality: Status and Trends*. Washington, DC: Office of Air and Radiation.

U.S. Environmental Protection Agency (EPA). *OAQPS Economic Analysis Resource Document.* <http://www.epa.gov/ttnecas1/econdata/Rmanual2/manual.htm.> Last updated April 1999b.

U.S. Environmental Protection Agency (EPA). Integrated Risk Information System. <http://www.epa.gov/ngispgm3/iris/index.htm.>. As obtained on October 15, 2000a.

U.S. Environmental Protection Agency (EPA). 2000b. "Recreational Vehicles, Marine Engines." Region III, Air Protection Division. Available at http://www.epa.gov/reg3artd/vehicletran/vehicles/recreational_vehicle> s.htm>.

U.S. Small Business Administration. "Statistics of Business: Firm Size Data." <http://www.sba.gov/ADVO/stats/data.html>. Last updated June 29, 2001.

U.S. Small Business Administration. 1998. *The Regulatory Flexibility Act: An Implementation Guide for Federal Agencies*. Washington: U.S. Small Business Administration.

VanMouwerik, M., and M. Hagemann, 1999. **"**Water Quality Concerns Related to Personal Watercraft Usage." Technical paper. Water Resources Division, Fort Collins, CO.

Wagar, J.A. 1977. "Recreational Carrying Capacity." In *Proceedings of the Wildland Recreation Conference*. pp. 168-175. Edmonton, Alberta: University of Alberta.

Wisconsin Department of Natural Resources (WDNR)—Bureau of Integrated Science Services. 2000. "The Effects of Motorized Watercraft on Aquatic Ecosystems."

Appendix A: Economic Impact Analysis

Expenditures made by visitors to national parks have a variety of economic impacts on the region where the park is located. For instance, tourists contribute to sales, profits, jobs, tax revenues, and income in a region. The most direct effects are felt within the primary tourism sectors: lodging, dining, transportation, entertainment, and retail trade. However, when indirect effects are included, almost all sectors of the economy are affected by tourism. This occurs because spending by tourists on the primary tourist sectors leads those sectors to purchase inputs into their production process from other industries, which then purchase more inputs themselves and so on. In addition, as local household income rises because of the impact of tourism, these households purchase more goods and services from many different industries. This leads to higher incomes for households deriving income from these other industries, which causes them to purchase more goods and services as well. These feedback effects continue indefinitely, but become smaller and smaller in each round as a result of leakage because not all income is spent within the regional economy. These effects on household spending are known as induced effects.

A simple example from Stynes (2000) illustrates this point. Assume a region attracts an additional 100 tourists, each spending $100 per day. The direct impact of this increase in tourism is $10,000 per day in new spending. If sustained over a season of 100 days, the region would experience an increase in sales of $1 million. This spending would primarily take place in the lodging, dining, entertainment, and retail sectors in proportion to how each visitor spends his/her $100. Not all of the value of this spending can be

assumed to accrue within this region because the cost of goods made in other regions should not be included as a direct sales effect in the local area. For example, gasoline purchased by tourists for $1.50 per gallon should not be included as a local spending impact of $1.50 per gallon. Instead, only the retail margin on the gasoline can be considered a direct effect of tourism spending. The margins on gasoline are relatively small. Assuming a retail margin of 12 percent suggests that the direct impact of spending on gasoline to the local area is only about 18 cents per gallon. Wholesale margins are also included for wholesalers located within the region of interest.

Returning to the example above, perhaps 30 percent of the million dollars in direct spending would leak out of the area to cover the costs of goods purchased by tourists that were produced outside the region. The remaining $700,000 increase in direct sales might yield $350,000 in income within tourism-related industries and support 20 jobs directly linked to tourism. Tourism industries tend to be labor intensive, translating a relatively high proportion of sales into income and jobs.

The tourism industry buys goods and services from other industries located in the area to provide the goods and services offered to tourists. For example, changes in sales, jobs, and income in the linen industry (an industry supplying products to hotels) will result from changes in hotel sales. Also, as mentioned above, this industry is typically very labor intensive. Therefore, most of the $350,000 in income will be paid as wages and salaries to tourism industry employees. As a result of this increase in income, these employees will spend more in the local region for an array of household products and services. Assuming a sales multiplier of 2.0 to indicate that each dollar of direct sales generates another dollar of secondary sales implies that the $700,000 in direct sales within the region leads to a $1.4 million increase in regional sales as a result of the additional tourists visiting the area. These secondary sales create additional income and employment in the region, with the estimated impact dependent on the multipliers for each particular region. Assume in our case that the total impact of the increase in tourism after applying multipliers is $1.4 million in sales, $650,000 in income and 35 jobs.

Although hypothetical, the numbers used in this example are fairly typical of those used in a tourism economic impact study. Through indirect and induced effects, changes in tourist spending can affect almost every sector of the economy to some extent. The magnitude of these effects depends strongly on the extent to which businesses and households in the region purchase goods and services from local suppliers as well as how much household income is affected by the changes in spending. When a large employer closes a plant, the entire local economy may be negatively affected as retail stores close and leakages of spending from the region increase as consumers go outside the region for more of their goods and services. Similar effects in the opposite direction are observed when a new facility opens and there is a significant increase in household income (Stynes, 2000).

In addition to simply estimating the total regional impact, more detailed studies identify the sectors that receive the direct and secondary effects. They may also identify distinct market segments and identify differences in spending and impact between these subgroups. This information is sometimes used to target marketing efforts towards tourists with particular characteristics that are likely to lead to the largest economic impact per marketing dollar. It may also be used simply to better understand the distribution of impacts and to gain a better measure of the expected effects of a change in regional spending. Effects on tax revenues may also be examined by applying local tax rates to changes in sales and income.

The economic impacts resulting from a change in spending are typically measured by

- ➤ estimating the change in the number and types of visitors to the region due to the proposed change in policy,
- ➤ estimating average levels of spending (often within market segments) of visitors in the local area, and
- ➤ providing the estimated change in direct spending as input into a regional economic model to determine secondary effects.

Estimates of changes in visitor activity usually come from a demand model or professional judgment about the changes in visitation likely to take place. This step is often the weakest link in tourism impact studies because most regions do not have accurate counts of

visitors, let alone models for predicting changes in visitation (Stynes, 2000).

Spending averages are usually derived from visitor surveys or may be adapted from other similar studies. Because of differences in visitors, these data are often provided for different segments of the visitor population due to variations in spending patterns based on whether visitors stay overnight, the accommodations they choose, the type of transportation they are using, and other characteristics of their stay.

One of the primary methods used to estimate the secondary economic impacts of a particular action or policy is to apply an input-output (I-O) model. I-O models are mathematical models that describe the relationship between sectors in a region's economy. Regional I-O models are commonly used to estimate the benefits or costs of an event on the economy of a given region. These models are used to estimate linkages among sectors of the economy such that an event directly affecting one sector of the economy can be traced through the impact on the entire regional economy. This approach permits estimation of both the direct impacts in the affected sector as well as indirect impacts that occur as the change in spending by the directly affected industry works its way through the economy. Based on production functions estimating the inputs that each industry must purchase from every other industry to produce their output, these models predict flows of money between sectors. These models also determine the proportion of sales that end up as income and taxes. Multipliers are estimated from I-O models based on the estimated recirculation of spending within the region. The higher the propensity for households and firms within the region to purchase goods and services from local services, the higher the multipliers for the region will be. A number of important assumptions are involved in using I-O models. Some of the basic assumptions include the following:

- **Constant Returns to Scale.** Each industry's production function is assumed to have constant returns to scale. This means that, to produce additional output, all inputs increase proportionately (i.e., if output in an industry were to double, then that industry would double its use of all inputs). Because labor is one of the inputs into production, this implies that jobs will change in exactly the same proportion as output.

- **No Supply Constraints.** Supplies are unlimited. All industries have access to unlimited quantities of raw materials at a constant price with output limited only by demand.
- **Fixed Commodity Input Structure.** This assumption implies that price changes do not cause a firm to purchase substitute goods. This structure assumes that changes in the economy affect the industry's output but not the mix of inputs it uses to make its products.
- **Homogeneous Sector Output.** The proportion of all the commodities produced by an industry will remain the same, regardless of total output. An industry will not increase the output of one product without proportionately increasing the output of all its other products.
- **Industry Technology Assumption.** This assumption is important when data are collected on an industry-by-commodity basis and then converted into industry-by-industry data. It assumes that an industry uses the same technology to produce all of its products. In other words, an industry has a primary product and all other products are by-products of the main product.
- **Identical Firms.** All firms in a given industry employ the same production technology and produce identical products.
- **Model Parameters.** The various model parameters are accurate and represent the current year. These models rely on the national system of accounts to generate model parameters based on standard industrial classification codes and various federal government economic censuses. They are usually at least a few years out-of-date, although this is not usually a major problem unless the region has changed significantly.
- **Induced Effects.** Multiplier computations for induced effects assume that jobs created by additional spending are new jobs involving local households. The induced effects of new spending are calculated assuming linear changes in household spending with changes in income.

These assumptions are necessary to estimate an economic impact model using a typical regional I-O model. However, these assumptions lead to several limitations as noted by Hamilton et al. (1991); Coughlin and Mandelbaum (1991); and Stabler, Van Kooten, and Meyer (1988), among others. Most of these issues apply to alternative models as well and should be considered in interpreting the results of economic impact analyses in general. Some of the biggest limitations associated with this type of analysis are discussed below.

First, all production inputs have an associated opportunity cost. Thus, these opportunity costs should be included in the net benefits calculation, although this is often not considered in an economic impact analysis. Net benefits equal impacts less opportunity costs. In the case of full employment, perfect resource mobility, and absence of scale economies, benefits of a policy, action, or project would be zero because all factors employed as a result could have received the same return without the policy, action, or project in alternative uses. Typically, applications analyzing regional economic analysis assume that there is not full employment and complete mobility in the region being analyzed, but the change in net benefits will still be reduced if opportunity costs are considered.

Another issue is that multipliers estimate short-term changes, ignoring a regional economy's long-term adjustments. Thus, most of the economic effects identified in economic impact analysis are likely to be only transitory as the regional economy adjusts to the change. For example, if jobs are lost in a region because of new regulations, some of this reduction will be temporary because some of the workers whose jobs were eliminated will find new jobs in the region.[1]

Also, if some workers relocate in response to a change in the regional economy, then it is not entirely clear who should be counted in the region when calculating the benefits and costs associated with a change. For example, a new project located in a particular region may attract resources from outside the region. It is not clear that income to these immigrant resources should be counted as regional benefits of the project because people originally from the region do not benefit. However, I-O models typically make no distinction between jobs and sales, for example, going to those people already within the region and benefits going to those people outside the region.

Furthermore, applying multipliers is difficult if industries will move to different points on their cost curves as a result of the change and there are economies or diseconomies of scale. Because I-O models are based on fixed coefficients, they are not able to capture these

[1]Some workers may not find jobs within the region, even in the long run. The loss of workers who leave for jobs in other regions may tend to slow the region's growth, but such restructuring ultimately improves national economic performance by redistributing resources to their most efficient use.

impacts. These models assume that there are no supply constraints such that industries will not change their relative purchases from other sectors. This requires excess regional production capacity and excess regional labor so that use of these resources can be increased without a change in prices. In many areas, this is unlikely to be the case. Instead, increasing scale may lead to an increase in the price of labor and other resources and may cause a change in the mix of inputs used for production. It may also lead to the use of a different proportion of inputs being purchased from outside the region, which will affect the estimated change in final demand for regional output.

Some additional difficulties with applying regional multipliers include the following:

- multipliers are based on political boundaries (e.g., counties, states) instead of economic areas;
- multipliers may not be constant over time;
- different production functions for different activities are lumped together; and
- information on the relationships between producers in a region is lacking, which makes constructing an accurate set of multipliers very difficult.

Despite these caveats on the use of multipliers, regional I-O models are still considered the best way currently available to cost-effectively estimate the regional impacts of a change that will affect the local economy.

Appendix B: Social Benefits and Costs of Personal Watercraft Restrictions

The purpose of benefit-cost analysis is to evaluate the social welfare implications of a proposed action—in this case the regulation of PWC use in national parks. That is, it assesses whether the action generates benefits to society (gains in social welfare) that are greater than the costs (losses in social welfare). The following sections provide detailed descriptions of the range of social benefits and social costs that may result from PWC restrictions and discuss the ways in which these benefits and costs can be conceptualized and measured.

B.1 SOCIAL BENEFITS OF PWC RESTRICTIONS

PWC use in national parks may be associated with a number of negative impacts on environmental resources and ecosystems. One result of any negative impacts that occur is that they impose welfare losses on individuals who value the parks' environmental systems. The benefits of PWC restrictions can therefore be thought of and measured as the reduction in these losses to society. In addition, PWC use can negatively affect society in ways that are not directly related to the environment; therefore, the benefits of PWC restrictions must also include reductions in these nonenvironmental losses. Both broad categories of benefits—environmental and nonenvironmental—are discussed in more detail below.

B.1.1 Environmental Benefits

The use of PWC may have adverse impacts on the aesthetic qualities of the park, on human health, and on the park's ecosystems. The benefits associated with avoiding these impacts are described below.

Aesthetic Benefits

Among the largest and most directly damaging impacts associated with PWC use in national parks are its effects on the aesthetic qualities of park air and specifically the park soundscape. The natural soundscape is considered a natural resource of the park, and NPS attempts to prevent or minimize unnatural sounds that adversely affect the natural soundscape. National parks are especially valued for their pristine and undisturbed environments, which are often experienced by visitors through natural vistas and through the relative absence of visible or audible human activity (NPS, 2000b). The improvement or preservation of these aesthetic qualities, either in the form of reduced noise pollution or improved visibility, is therefore a potentially important source of benefits from reducing PWC use.

Noise Reduction. Perhaps the most noticeable and intrusive aspect of PWC is the level of sound they emit during normal operation. PWC have been measured to emit 65 to 105 decibels (dB) per unit, which may disturb visitors on the land and on the water. Noise limits established by NPS require vessels to operate at less than 82 dB at 82 feet (from the shoreline). The amount of noise from a PWC can vary considerably depending on its distance from another park visitor and whether it is in the water or in the air. Noise dissipates by 5 dBs for each doubling of distance from a 20-foot circle around the source and a PWC that is airborne is 15dB louder than one that is in the water (Komanoff and Shaw, 2000). To put these noise-level estimates into perspective, Table B-1 also compares them with those of other familiar sounds. Vehicle noises are measured at a distance of 50 feet, but at varying speeds.

PWC users tend to operate close to shore, to operate in confined areas, and to travel in groups, making noise more noticeable to other recreationists. Noise impacts from PWC use are caused by frequent changes in pitch and loudness due to rapid acceleration, deceleration, and change of direction. PWC noise intrudes in

Table B-1. Comparative Noise Emissions

Source	Decibel Level
Firearms	140
Motorcycle	90–110
Snowmobiles	73–100
Vacuum cleaner	70
PWC	65-105
Normal conversation	60
Normal breathing	10

Sources: League for the Hard of Hearing, 2000; Overseas Marketing Group (OMGSIC), 2000.

otherwise quiet soundscapes, such as in secluded lakes, coves, river corridors, and backwater areas. Also, PWC use in areas where there are nonmotorized users (such as canoeists, sailors, and kayakers) causes conflicts between users.

Those who are most likely to benefit from reductions in PWC-related noise pollution in national parks are other park visitors and recreators, in particular those engaged in recreational activities that take place by the water, such as fishing, hiking, birdwatching, canoeing, kayaking, and swimming.

Several studies have shown that noise from motorized vehicles diminishes the recreational experience of other users. Several studies have found disamenities associated with various forms of mechanized recreational activities or other "technology-related" noises in recreation areas (Beal, 1994; Ivy, Stewart, and Lue, 1992; Bury and Luckenbach, 1983; Baldwin, 1970; Bury, Wendling, and McCool, 1976; Dunn, 1970; Lucas and Stankey, 1974; O'Riordan, 1977; Sheridan, 1979; Wagar, 1977).

Relatively few studies have specifically estimated the (negative) value of noise externalities on other recreators. One exception is a recent analysis conducted by the Federal Aviation Administration (FAA) to estimate the benefits of a regulation to restrict commercial air tours in Grand Canyon National Park (GRCA) (FAA, 2000). Using visitor-day value estimates from existing studies ranging from $37 to $92 (for backcountry, river, and other users of the park), the analysis assumed that these visitor-day values would be reduced in

relation to the how much aircraft noise interfered with the enjoyment of GRCA. Information about how aircraft noise affected different recreators was provided by a separate survey study of GRCA visitors. The survey found, for example, that for backcountry visitors 21 percent were "slightly" affected and 2.5 percent were "extremely" affected by the aircraft noise. In the FAA analysis, visitor value-days were assumed to be reduced by 20 to 80 percent depending on the percentage of respondents who indicated that their enjoyment of the park was "slightly," "moderately," "very," or "extremely" affected by the noise.

Another example of such a study that focuses specifically on the noise impacts of PWC is one that has examined the losses that PWC users impose on other beach recreators (Komanoff and Shaw, 2000). This study assumed that an average beach day (per person) is worth between $10 for a popular beach and $30 for a secluded one and that each 10 dB increase in background noise decreases these values by 10 percent. The assumptions about the size of the decrease in value from increases in noise come from studies on the increased property values for houses in quiet neighborhoods. Assuming also that each 1 dB noise level increment reduces the value of a beach day by 1 percent, the study found that beachgoers suffer an average loss in recreation value of between $0.50 and $7.40 per jet ski cluster (1.6 jet skis over the course of a day) per person per day.

Other evidence regarding the noise-related losses imposed by PWC can be gleaned from studies that have examined the effects of congestion on recreation values. In these studies, congestion is often measured as the number of encounters with other recreators, which may be thought of as being roughly equivalent to hearing the sound of PWC. For example, in a study of backcountry recreators in the Caribou-Speckled Mountain Wilderness in Maine, Michael and Reiling (1997) found that weekend visitors experienced losses of $22.3 (in 1990 dollars) per visit if they encountered more groups than expected.

Visibility Improvements. Several studies by the NPS and others have demonstrated the importance of visual air quality for visitors' (and nonvisitors') enjoyment and appreciation of national parks. Nevertheless, visual air quality has been and continues to be threatened at many national parks across the country. Emissions

from PWC in these parks are one of many potential (albeit, a relatively small) sources of these visibility impairments.

Although visibility effects can be characterized and measured in several different ways, "regional haze," which uniformly reduces visual range and therefore impairs the appreciation of natural vistas, has been a particular source of concern. The primary contributors to regional haze and visibility impairments in general are small particles (particulate matter or PM) in the atmosphere that scatter and absorb light. There are several different sources and types of particles in the environment; however, sulfates (and to a lesser extent nitrates), primarily from the combustion of fuels, are the largest contributors to visibility reduction, especially in the eastern portions of the U.S. (Malm, 1999). Nationwide, the largest sources of sulfur dioxide emissions that contribute to sulfates in the atmosphere are power plants and other industrial sources. Mobile sources, such as cars, trucks, and buses (and PWC), account for the largest portion of NO_X emissions, which contribute to nitrates.

Emissions factors per hour are not available for PWC but because PWC are powered by the same type (two-stroke) of engine as snowmobiles, snowmobile emissions factors may serve as a reasonable proxy. Table B-2 compares typical emissions rates for snowmobiles and other vehicles for NO_X and PM. These are the pollutants that are the most likely contributors to visibility impairments from PWC emissions. These emissions rates vary greatly across types and uses of these vehicles; however, the table shows that PM emissions for snowmobiles are particularly high relative to automobiles. The California Air Resources Board found that a 7-hour ride on a PWC powered by a conventional two-stroke engine produces the same amount of smog-forming emissions as over 100,000 miles driven in a modern passenger car. It should also be noted, however, that automobiles account for a very small portion of PM emissions nationwide.

The estimates in Table B-2 suggest that PWC can be a source of visibility impairment in national parks, but their contribution to overall levels of regional haze in these areas is likely to be negligible. Nevertheless, in high-use areas and periods, they may negatively affect visual air quality in a noticeable way.

Table B-2. Comparative Emissions Factors for Snowmobiles and Other Vehicles: NO_X and PM

	NO_X	PM
Snowmobiles (lbs per 4 hr visit)	0.06	0.2
Automobiles (lbs per 4 hr drive[a])	0.09–0.41	0.02
Diesel buses (lbs per 4 hr drive[a])	3.22	0.26

[a]Assuming an average speed of 25 mph.

Source: NPS, 2000a.

Several studies have investigated U.S. households' values for improvements in visibility at various national parks across the country. All of these studies have found a significant WTP by both users and nonusers for visibility improvements. One study in particular (Chestnut and Rowe, 1990) found that the average household in the southeast U.S. would be willing to pay $68 (in 1999 dollars) per year for a doubling of the visual range in national parks in the southeast U.S.

Human Health Benefits

In addition to NO_X, ozone, and PM, PWC emissions typically contain a number of other pollutants, including CO, a conventional air pollutant that is commonly associated with mobile sources. It also includes a number of potentially toxic HC pollutants—benzene, 1,2-butadiene, formaldehyde, and acetaldehyde—and ammonia. As described in Table B-3, inhalation of these pollutants is associated with a wide variety of potential adverse health effects.

The extent to which the health effects listed in Table B-3 result from PWC emissions depends on the level and duration of exposure. For comparative purposes, Table B-4 compares emissions rates of HCs and CO for snowmobiles (as in Table B-2, snowmobile emissions factors serve as a proxy for those of PWC) and for other vehicles.

The comparisons for CO are particularly relevant since highway vehicles account for over 50 percent of total CO emissions in the country (EPA, 2000b). Although the measures of vehicle use in the emissions factors are different across vehicles, the rates of HC and CO emissions for snowmobiles are distinctly higher than for

Table B-3. Health Effects Associated with Pollutants in PWC Emissions

	Carcinogenic Effects	Other Chronic Health Effects	Acute Health Effects
Particulate matter (PM)	None	Chronic bronchitis	High-level exposure: mortality, acute bronchitis Low-level exposure: cough
Carbon monoxide (CO)	None	Aggravation of cardiovascular disease	High-level exposure: visual and mental impairment
Nitrogen oxides (NO_X)	None	Reduced pulmonary function	High-level exposure: cough, fatigue, nausea Low-level exposure: lung irritation
Benzene	Known human carcinogen	Anemia and immunological disorders	High-level exposure: dizziness, headaches, tremors
1,3-Budatdiene	Probable human carcinogen	Birth defects, kidney and liver disease	High-level exposure: neurological damage, nausea, headache Low-level exposure: eye, nose, throat irritation
Formaldehyde	Probable human carcinogen	NA	NA
Acetaldehyde	Possible human carcinogen	Anemia	High-level exposure: pulmonary edema, necrosis Low-level exposure: eye, skin, lung irritation
Ammonia	None	NA	High-level exposure: eye and lung irritation

NA = Not available

Sources: EPA, 2000a; EPA, 1999a.

Table B-4. Comparative Emissions Factors for Snowmobiles and Other Vehicles: HC and CO

	HC	CO
Snowmobiles (lbs per 4 hr visit)	19.84	54.45
Automobiles (lbs per 4 hr drive[a])	0.09–0.44	0.75–3.24
Diesel buses (lbs per 4 hr drive[a])	1.23	4.45

[a]Assuming an average speed of 25 mph.

Source: NPS, 2000a.

automobiles and diesel buses. As a result, national park visitors recreating near areas where PWC use is permitted may be exposed to particularly high levels of CO and certain HCs.

Restrictions on PWC use in national parks could potentially reduce harmful exposures to park visitors and workers, particularly for individuals who spend extended periods in high-use areas. The benefits of these restrictions can be expressed as the value of reductions in the incidence (i.e., the number of cases avoided) of harmful health effects, in particular those effects described in Table B-3. As previously mentioned, the total number of avoided health effects is not known; however, using information from a recent EPA study of the benefits of air pollution regulations (EPA, 1997), Table B-5 provides a summary of "unit" values for selected health effects. Based on a review and synthesis of several health valuation studies, these values represent best estimates of individuals' average WTP to avoid a single case of the health effect. In the absence of more complete information on the total health benefits of reducing PWC use, these values provide a rough sense of the magnitude and relative size of the benefits associated with avoiding specific health effects that may result from acute exposures.

Table B-5. Unit Values for Selected Health Effects

Health Effect	Unit Value (mean estimate) (1999$)[a]
Acute bronchitis	$57
Acute asthma	$41
Acute respiratory symptoms	$23
Shortness of breath (one day)	$6.8

[a]All amounts inflated using the consumer price index available from the U.S. Bureau of Labor Statistics, 2000.

Ecosystem Protection Benefits

To the extent that damages to park ecosystems occur, their cumulative effect is to reduce the "ecological services" that these systems provide to individuals and households across the country. National park ecosystems are particularly valued for their unique biological, cultural, and geological resources and the recreational and other services they provide. A vast majority of park visitors (i.e., users) experience and enjoy the natural systems of the park through a wide variety of recreational activities (wildlife viewing, hiking, fishing, as well as using PWC). However, even individuals

who are not park visitors (i.e., nonusers) can benefit from the knowledge that park resources are being protected and preserved. These nonuse values can stem from the desire to ensure others' enjoyment (both current and future generations) or from a sense that these resources have some intrinsic value. Evidence of such nonuse values for park protection is provided in studies that have documented significant WTP by nonusers for improved air quality at parks (e.g., Chestnut and Rowe, 1990) and, more generally, for the protection of unique species and ecosystems (see, for example, Pearce and Moran [1994] for a review of such studies). Restrictions on PWC use in national parks can therefore provide benefits to both users and nonusers in a number of ways by protecting the parks' ecological resources.

B.1.2 Nonenvironmental Benefits

Restrictions on PWC use in national parks can also improve societal welfare in ways that are not directly related to environmental quality in and around the parks. These potential nonenvironmental benefits are described below.

Public Safety Benefits

With the increase in PWC use in recent years has come an increased concern relating to the health and safety of operators, swimmers, snorkels, divers, and other boaters. A study conducted by the National Transportation Safety Board (NTSB) in 1998 revealed that although recreational boating fatalities have been declining, PWC related fatalities have increased in recent years (NTSB, 1998). PWC accident statistics provided by the U.S. Coast Guard supports the increase in PWC-related fatalities. Within the U.S. five PWC-related fatalities occurred in 1987 and 68 PWC-related fatalities occurred in 2000. However, the peak occurred in 1997, with 84 PWC-related fatalities. Since 1997, PWC-related accidents, injuries, and fatalities have decreased. Following this same pattern, the percentage of PWC out of all boats involved in accidents have decreased from 36.3 percent in 1996 to 29.6 percent in 2000. The increases and decreases in PWC accidents, injuries, and fatalities are comparative to the number of PWC sales and number of PWC owned (Schmidt, 2001).

Restrictions on PWC use in national parks would certainly reduce the number of such incidents in the parks.[1] The primary beneficiaries would be the PWC users themselves, whose safety would be protected; however, these benefits may be implicitly accounted for in the consumer surplus changes (see Section C.2) that these recreators experience as a result of the restrictions.[2] Other summer recreators (non-PWC) might also benefit if they would otherwise be at risk of being involved in accidents with PWC. In addition, PWC accidents can impose costs on NPS and other local state and local government agencies that are responsible for providing medical, rescue, and related assistance. Reductions in PWC accidents in national parks would therefore allow some of the resources devoted to these activities to be diverted to other publicly beneficial uses.

Avoided Infrastructure Costs

Allowing PWC in national parks requires NPS to develop, maintain, and operate an infrastructure to support these activities. In particular launch sites and buoys must be designated, maintained, and monitored. The costs associated with these activities vary widely across parks, depending on the physical characteristics of the parks and the level of PWC use permitted.

By restricting PWC use, some of these infrastructure-related costs can be avoided or reduced. As a result some of the resources devoted to these activities can also be diverted to other publicly beneficial uses.

B.2 SOCIAL COSTS OF PWC RESTRICTIONS

The primary losses associated with PWC use restrictions in national parks will accrue to

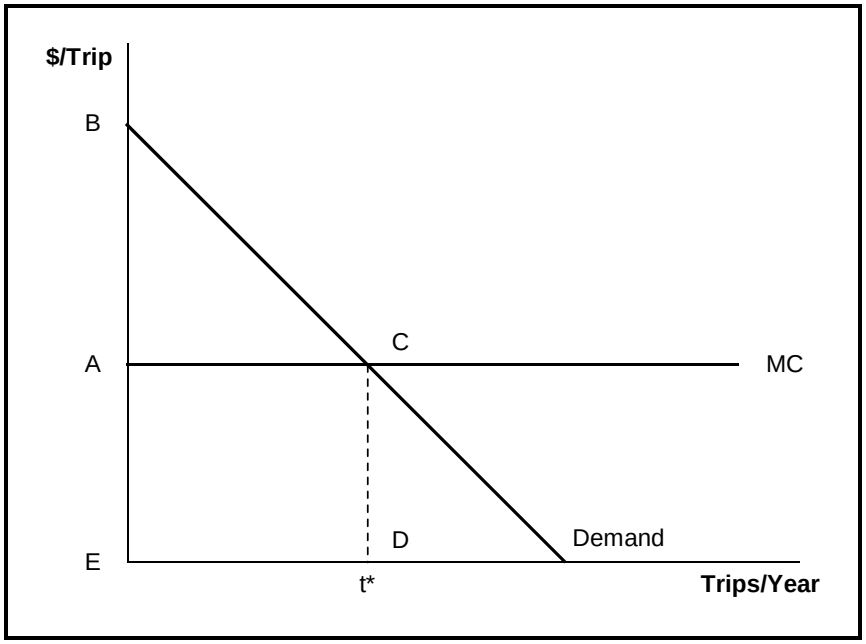
- ➤ PWC users, in particular individuals who will not PWC in the park as a direct result of the restrictions, and
- ➤ providers of PWC-related services for park visitors.

[1]The benefits of these reductions may be offset to some degree by increased PWC usage and accidents in areas outside the parks.

[2]To the extent that PWC users are aware of the safety risks they face, the potential losses to themselves from accidents should already be factored into their consumer surplus from using a PWC. This implies that the safety benefits to these individuals from reducing PWC use are implicitly accounted for (i.e., deducted from) the consumer surplus losses to these recreators.

The welfare losses to individual consumers (PWC riders) are measured by their loss in consumer surplus. Consumer surplus is measured as the difference between the total cost of a product or activity to the consumer and the total amount the individual would be willing to pay for that activity. In the context of recreation activities, Figure B-1 depicts an individual demand curve for PWC trips, the marginal cost of a trip (MC, assumed to be constant), and the optimal number of trips per year, t*. The triangle ABC measures the consumer surplus associated with this optimal number of trips—the difference between what the individual paid for the trips, ACDE, and the total WTP for the trips (the area underneath the demand curve), EBCD.

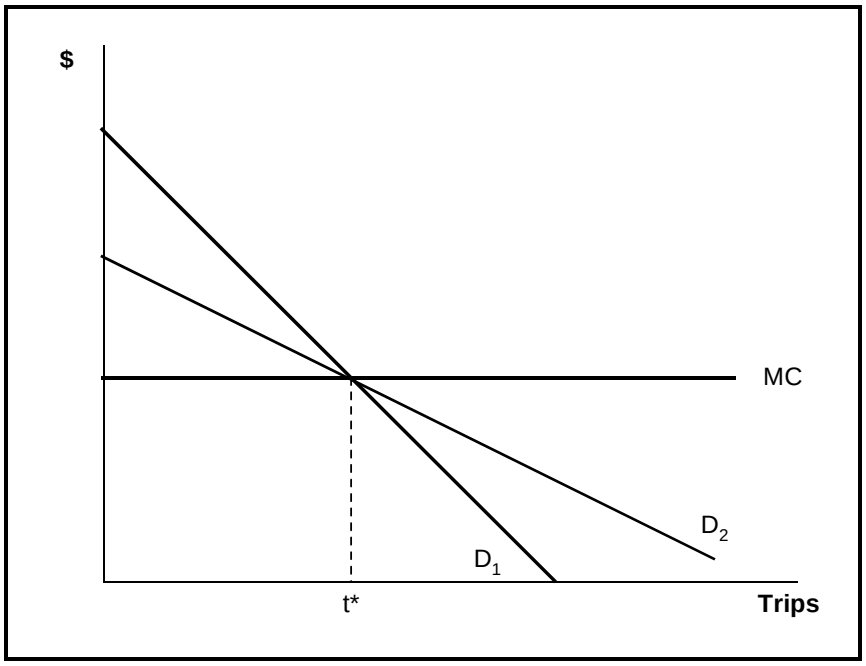
Figure B-1. Consumer Surplus



The extent of the welfare loss to an individual rider depends crucially on the availability of substitute activities. Figure B-2 depicts two alternative demand curves for PWC trips to a particular waterbody. The slope of the demand curve reflects the number of substitute activities available to a particular individual and the preferences of that individual toward those substitutes. The flatter demand curve, D_2, indicates that this individual has a variety of close substitutes for PWC use in this area (these substitutes could include PWC riding in a different area or participating in a different activity such as motorboating). The individual with the steeper

demand curve, D_1, has fewer substitute activities he/she enjoys as much as using his/her PWC in this waterbody. If both individuals choose the same number of trips, as in Figure B-2, the person with the steeper demand curve, D_1 (fewer substitutes for PWC use) receives greater consumer surplus from use in this particular waterbody and thus will experience a greater loss in welfare if the waterbody is closed.

Figure B-2. Consumer Surplus and Substitute Activities



The change in welfare for businesses is measured by producer surplus, or the area AP*B in Figure B-3, where P* is the market price of the good, for example a PWC rental. Producer surplus measures the difference between total revenue and variable costs. If the firms face an upward- sloping marginal variable cost (MC) curve, then a decrease in demand, indicated in Figure B-4 from D to D' will result in a lower producer surplus for PWC rental companies.

Figure B-3. Producer Surplus

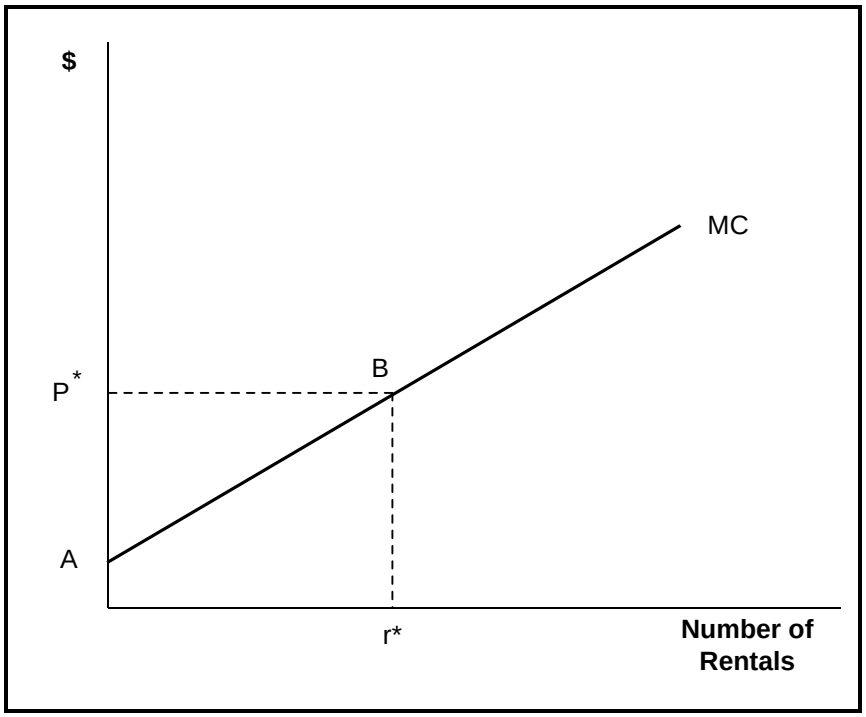
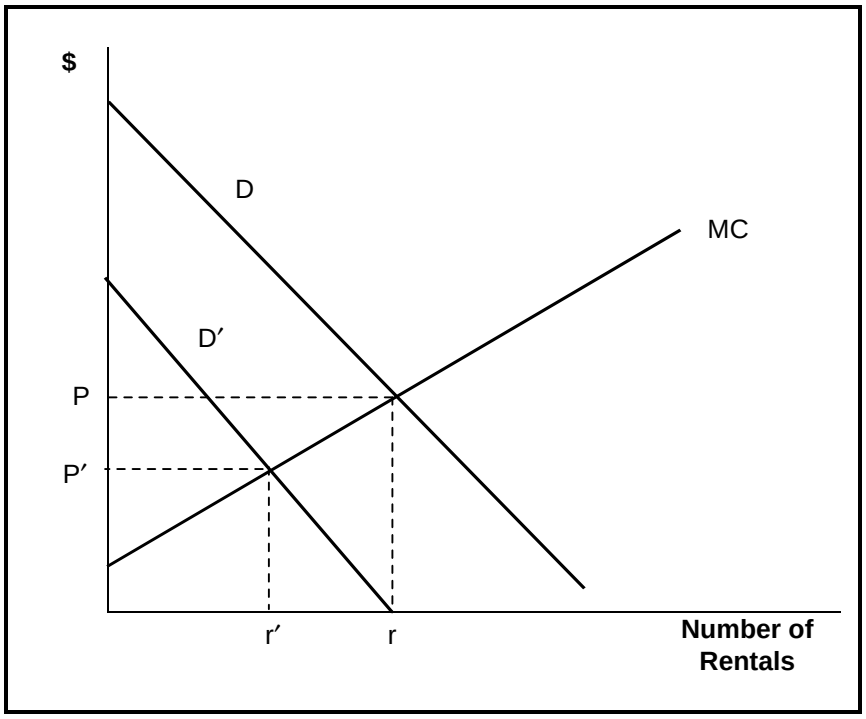


Figure B-4. Producer Surplus and a Change in Demand



If PWC riding decreases as a result of the regulation, then the suppliers of PWC and other tourism-related services will be affected, including rentals and sales of PWC and PWC accessories, lodging, meals, and other tourism-related expenditures. If demand for other types of recreation related rentals increases, then some businesses may experience an offsetting increase in producer surplus.